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Technical Reference Branch
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INCREASING SAFETY BELT USE THROUGH STRUCTURED EDUCATIONAL PROGRAMS—IS IT POSSIBLE?

John D. DeLellis

American Automobile Association

ABSTRACT

Various measures to improve vehicle occupant protection are currently being proposed, including mandatory safety belt use laws and passive restraint standards. This paper suggests an alternative approach, utilizing a hypothetical educational program in a formal, structured setting. A rationale is developed for including safety belt instruction in high school driver education. Increased safety belt usage rates by driver education students and improved cost-benefit values for driver education courses are identified as potential outcomes. Instructional problems at the high school level are addressed. Objectives and

a content outline for a model safety belt program are defined, as are characteristics of "target" audiences. The issue of feasibility of an education approach is examined, with emphasis on past attempts to influence safety belt use through mass media, such as television. Expected outcomes from a well-designed safety belt instructional program are described and a cost-benefit hypothesis is made. The paper concludes that it is possible for a properly-designed and implemented safety belt instructional program, when administered in a structured, educational setting, and directed to specific groups, to result in cost-effective increases in safety belt usage.

ning, teenage drivers had been widely assumed to reduce accidents and violations up to 50%.

However, most studies that reached this conclusion failed to control for the effects of significant variables such as socioeconomic status, sex and driving exposure². Secondly, few if any studies randomly assigned test populations to HSDE (high school driver education) and non-HSDE control groups. Nor did they identify the component parts of the curriculum used in the target driver education programs.

More recent studies have also failed to substantiate the "50% fewer accidents" figure and in fact, none of the recent research projects have been able to demonstrate any substantial crash reduction among course graduates.

One crucial ingredient that recent studies^{2,3} have identified (i.e., an ingredient critical to program effectiveness as a life-saving and accident-reduction countermeasure) is the implementation of a performance-based curriculum with well-designed objectives.

The key to future program effectiveness and improvement therefore is better design of curriculum. Assuming that an objective-based and performance-based curriculum can be identified and implemented, the National Highway Traffic Safety Administration has taken the position that a 10 to 15% crash reduction rate for driver education course graduates is a reasonable expectation⁴.

Including Safety Belts in the Curriculum

With a 15% reduction of accidents as a maximum realistic figure, we can then conclude that a curriculum designed to improve driver performance (to achieve that goal) must be more broadly defined—to include not only specific driving performances such as perceptual and decision-making tasks but also to include emphasis on pre-driving protective measures to cushion the effect of system (vehicle, roadway environment and driver) failures.

In other words, while emphasis must be placed on improving driver performance to prevent crashes, emphasis must also be placed on driver responsibility for making maximum use of in-vehicle, "active" (i.e., requiring conscious user implementation) safety devices, designed to minimize crash injury conse-

quences. This requires that drivers understand and use the safety features such as safety belts. Passive devices, such as padded dashes and collapsible steering columns require no user action and therefore require no user education.

An added reason for increased emphasis on safety belt training in driver education is that its potential "payoff" is high, both in terms of collision avoidance (i.e., their use reduces fatigue on long trips and keeps the driver in position behind the wheel⁵ during emergency-evasive maneuvers) and injury severity reduction if a collision occurs.

Instructional Problems

Two studies state that driver education graduates have below average belt use. Rodolf⁶ concluded that drivers are more likely to wear seat belts as their age increases. He also concluded that the 20–24 age group used restraint devices less, proportionately, than did older age groups. Rossman's⁷ findings are supportive. Based on surveys and visual observation of 600 drivers, those drivers who completed a driver education course were actually less likely to wear seat belts than those who did not take driver education. Rossman's data demonstrated that the 16–20 age group had the lowest seat belt use rate. These findings are reinforced by initial Ontario belt use law data cited by the Insurance Institute for Highway Safety: "The law had no apparent effect on belt use by teenage drivers . . ." Yet the law resulted in significantly increased usage by other age groups.

These findings may indicate inadequate emphasis on safety belts in driver education classes, ineffective teaching approaches or poor personal use examples by teachers (i.e., the "do as I say, not as I do" approach). Recent findings by Gilbertsen-Pangercic⁸ tend to substantiate these theories. In a survey of 759 suburban driver education students, 18% of the students indicated that the classroom teacher did not emphasize safety belt usage; 52% indicated that the practice driving teacher wore only the lap belt; and 15% stated that the practice driving teacher wore no safety belts during in-car instruction.

These factors are all the more reason for added emphasis on safety belt use in driver education.

traffic mix still dominated by larger vehicles¹⁸.

Non-Instructional Methods of Increasing Safety Belt Use

Although the "payoff" from wearing safety belts in a crash is extremely high*, the majority of drivers and passengers do not use them²⁰. Well-enforced mandatory belt-use laws** would markedly increase use rates, but even the most optimistic observers predict at least six years will be needed to achieve their adoption in all 50 states¹⁸.

Short of increasing voluntary belt use, passive restraint systems such as airbags remain the only other possibility for reducing injuries and fatalities. (Current passive restraint system designs still require the use of lap belts to be truly effective in rear and side impacts.) Yet airbags are politically controversial^{21,22} due to questions concerning reliability, effectiveness and cost, and would probably require extensive developmental testing and engineering prior to mass production. The process of rulemaking and appeals to require airbags would also be time-consuming and once they became a requirement, a lead time of two

* Preventing a fatality has been estimated to save society \$200,725 while prevention of an injury can save society an average of \$7,300¹⁹.

** Safety belt educational efforts will probably remain essential if mandatory safety belt use laws are enacted. The potential *misuse* of belts tends to increase when more people wear them involuntarily—as compared to *voluntary* use by people motivated to wear them correctly. To support this theory, the 1975 edition of *Accident Facts* reports an Australian study in which one third of the belts were worn loose, one-fourth were twisted and only 14 percent of the drivers had their belts correctly adjusted. Since Australia has a mandatory use law, these figures can probably be accurately projected for those American states that adopt mandatory use laws.

And even if airbags are mandated and mass production begins in the 1980's, it would take another ten years before most cars in use were airbag-equipped. By then, today's teenager will be in or near his or her thirties.

Clearly, other options—such as increased voluntary use of existing belt hardware—have the best short-term potential for injury and fatality reduction, given the difficulties facing passive restraints and mandatory belt use laws.

A recent NHTSA study⁴ has indicated that because safety programs in the U.S. are already so extensive, future reductions in crash rates will be difficult to achieve since the average driver's probability of crash involvement is already so low. According to NHTSA's interpretation of National Safety Council figures^{4,23}:

- more than 78 percent of all licensed drivers in any one year are not involved in any type of crash
- approximately 98 percent of all licensed drivers in any one year do not suffer any form of serious injury resulting from an automobile crash
- more than 99.95 percent of all licensed drivers in any one year are not killed in a fatal crash

Therefore, significant reductions in total fatalities and collisions will "... probably require large-scale national approaches that have some significant impact on the Nation's drivers and passengers in terms of how they drive (e.g., using seat belts, minding speed limits) or how much they drive (e.g., in the recent fuel shortage)"⁴.

All of the approaches cited (use of safety belts, speed reductions, less driving) will help avoid collisions, but once a collision occurs, wearing safety belts remains the most effective countermeasure currently available.

usage should be the objective of any driver education program. The objective can be achieved by providing scientifically valid information concerning the value of safety belts and their correct use—in a structured learning experience, and in a manner designed to overcome fears and psychological resistance to their use.

Materials in the instructional package could be designed for a dual audience of beginning drivers and older, “experienced” drivers. Thus the total audience would include all 125,100,000 licensed drivers²⁴ and indirectly, their passengers.

Characteristics of “Target” Audiences

Safety belt training would have high payoff for all driver education students. The young, beginning driver group for instance is substantially overrepresented in motor vehicle crashes and fatalities. Drivers aged 15 to 24 comprise 21.8% of the licensed driver population yet account for 37.3% of all fatal crashes²⁴. That this young driver overinvolvement factor is so clearly recognized by the public is one reason why driver education programs are so strongly supported. Yet even the best hypothetical driver education program (and not all programs are top quality) is estimated to have a maximum reduction effectiveness of 15% in collision involvement⁴. Even

Thus, any improvement in safety belt usage by this group will substantially reduce the injuries and fatalities resulting from the still-high rate of collision overinvolvement.

Safety belt training could also be directed effectively toward “high-risk” adult drivers who are overinvolved in accidents and violations—especially if you accept Rodolf’s premise⁶ that the use of seat belts is linked to avoidance of risk in most other areas. Since mandatory driver improvement classes tend to have a high percentage of “high-risk” drivers (i.e., overinvolvement in accidents and/or “at-fault” violations) and since “high-risk” drivers would be less likely to wear safety belts, the payoff—if usage rates can be increased—is potentially high for safety belt training with such driver populations. The premise that accident and/or violation-overinvolved drivers tend to wear belts less is also supported by a study comparing seat belt use among drivers in accidents and drivers in the population at risk¹⁰. The analysis of 10,725 North Carolina drivers clearly shows that drivers in accidents use belts significantly less than drivers not in accidents.

Non-Accident Drivers	: 26.52%	Wearing Seat Belts
Property Damage Drivers:	10.63%	Wearing Seat Belts
Injury Drivers	: 7.04%	Wearing Seat Belts
Fatal Drivers	: 1.04%	Wearing Seat Belts

(such as "The Human Collision" prepared by the Ontario Ministry of Transportation and Communications or two NHTSA booklets titled "Safety Belt Instructional Booklet" and "Instructor Guide")

A comprehensive, illustrated booklet should completely cover the topic of safety belts for an audience of beginning or experienced drivers. Although part of a four-part package, it should be designed for separate use if desired (e.g., in the form of handouts to interested motorists and passengers). However, its most effective use would be as part of a total package, in a structured learning experience.

- B. An instructor's guide keyed to the student booklet: The guide should provide additional support data for the instructor while suggesting guiding questions keyed to the booklet and concepts that the instructor should emphasize in the student booklet.
- C. A transparency series or film strip keyed to the content of the booklet.
- D. A learning-activities guide featuring supplemental activities for students, including:
 - 1. Class activities
 - 2. Out-of-class projects
- E. Evaluation measures
 - 1. Short-term
 - a. Pre- and post-tests
 - 1. Knowledge
 - 2. Attitude
 - 2. Long-term.

B. FACTS

- 1. Research
- 2. Vehicle Crash Dynamics*

C. MYTHS*

- 1. Fire
- 2. Drowning
- 3. Ejection
- 4. Injuries from the Belts Themselves

D. ADVANTAGES OF SAFETY BELT USE

- 1. Control in Emergencies*
- 2. Comfort
- 3. Protection

E. DRIVER RESPONSIBILITY

- 1. To Passengers*
- 2. Legal Responsibilities
- 3. Influencing Others

F. HOW TO WEAR SAFETY BELTS

- 1. Adults
 - a. Large/Small Adults
 - b. Pregnant Women
- 2. Children
- 3. Infants

G. OTHER PROTECTIVE DEVICES

H. REFERENCES

* Areas that should be given special emphasis

the Fourth International Congress on Automotive Safety²⁵ revealed voluntary wear rates for three-point belts of 51.5% on British expressways and 44% on rural roadways. Current American usage rates are not nearly as high at 22%²⁶ but there is some evidence from recent surveys^{26, 27} that as newer vehicles with improved safety belt designs enter the vehicle population, occupant usage rates are increasing. Robertson's study²⁰ in particular definitely indicates that belt use is higher in newer vehicles. The constant improvement in restraint system design may thus be overcoming some objections previously raised by many motorists, such as inability to reach all controls.

Improvements in Belt Designs Will Help Lessen User Resistance

Robertson's findings²⁰ tend to be supported by a Volkswagen analysis²⁸ of U.S. buyer response to a safety belt "passive restraint system" that is available as a mandatory option in certain model Volkswagen Rabbits. The Volkswagen analysis was based on a questionnaire sent to 395 Rabbit buyers to which 160 responded.

The VW "passive restraint system" consists of an inertia-reel shoulder belt that attaches to the passenger door post in such a manner that once the belt is connected (a voluntary action by the driver and/or passenger, thus making the system not a truly passive system) a front seat passenger or driver can fairly easily enter or exit from the car without having to disconnect and reconnect the belt. An energy-absorbing lower dash at knee level and an ignition interlock that requires front seat occupants to be belted before the engine can be started completes the VW "passive restraint system."

The VW analysis found that while 39% of the respondents specifically wanted the option prior to purchase, after a few months of exposure to the system, 81.5% indicated they would like the "passive restraint system" on their next car. A more significant finding is that 77% of the respondents who claimed that they rarely if ever wore seat belts in their previous car (39% of those responding) stated that they would like the "passive restraint system" (in reality a superior, semi-passive, safety belt design, from the point

total vehicle and occupant population, the data does tend to indicate that as belt systems are improved, voluntary usage rates can be increased from the current 22% figure.

However, it should be pointed out that the VW "passive restraint system" is marketed as part of a deluxe interior/exterior package. There may thus be a tendency on the part of purchasers to get their "money's worth" by utilizing each part of that package. To quote VW's 1976 sales literature²⁹, "There are no buckles to fumble with, no airbags and plumb-ing. You strap yourself in securely simply by closing the door."

The gradual overall improvement in belt design may thus help convince more people to use them in the future. At the very least, there will be less of an obstacle in the form of mediocre designs.

Mass Media Campaigns

Another possible obstacle to increased safety belt usage is the concern expressed by many that significant increases in safety belt usage rates cannot easily be achieved through voluntary means. Advocates of mandatory safety belt use laws and/or passive restraint standards point to the ineffectiveness of numerous past campaigns to influence safety belt use. To quote one study (³⁰, p. 1):

"Campaigns promoting the use of safety belts have been based on inadequate knowledge of the factors contributing to lack of use. Slogans such as 'buckle up for safety,' 'lock it to me,' 'what's your excuse,' and the like, have been the hallmarks of these campaigns."

However, the very ineffectiveness of past television "spot" campaigns should be an indication that more structured, educational programs may be more effective in increasing occupant protection.

The study quoted demonstrated no significant differences in belt use after exposure to the television spots. However, there are several possible explanations for the inability of this extensive campaign to influence behavior. Most of the spots graphically portrayed disfigurements and injuries (scarred faces,

to such content. An example is provided by Malfetti (32, p. 14) that has implications even for those "scare" campaigns that offer a specific constructive suggestion (i.e., instead of the vague admonition to "drive safely," the suggestion is made that wearing safety belts will help avoid consequences portrayed):

"The author was present about two years ago at a showing of gory slides of accidents that could have been less injurious if seat belts had been worn. The purpose of the meeting was to encourage the use of seat belts. Since then I have talked with about 20 people who were there. Without exception we covered extensively the gory nature of the slides. But there was no mention of seat belts. We remembered the effects of the poison but forgot an antidote."

Death and disfigurement of injury are simply not themes with which people are comfortable or with which they readily associate.

Considering the gruesome content of many of the spots, it is not surprising that the campaign was in-

Their reaction may be one of annoyance at being so "harassed," or one of indifference, perhaps expressed by using the safety belt "commercial" to grab a quick snack or a cold beer.

If, however, people were in an educational setting, for a purpose specifically identified as improving driver performance, safety belt instruction would come as no surprise to them. Nor would it have to "turn them off" by using "scare" tactics.

Perhaps we are expecting too much from the brief exposure to a safety belt message in the midst of commercial programming. The lack of results from TV spot campaigns should not convince us that more structured educational programs aimed at specific groups—such as the successful Ontario seat-belt education project for second and third grade children—will have no effect. The Ontario program resulted in significant increases in usage rates by parents of children exposed to the program³⁴.

the content of a safety belt unit by qualified instructional staff in a manner consistent with its design and structure, then the following outcomes can reasonably be expected for persons successfully completing the unit:

1. Greater awareness of vehicle crash dynamics and the ability of lap/shoulder belts to safely distribute impact forces on the human body.
2. A reduction in beliefs held by many persons concerning safety belt "myths."
3. An understanding of how safety belts can improve driver control in lateral-evasive maneuvers.
4. An understanding of how safety belts can lessen driver fatigue.
5. The ability to differentiate between correctly-worn and incorrectly-worn safety belts.
6. The ability to explain to others (e.g., passengers) the advantages of, and reasons for, wearing safety belts.
7. The ability to describe inspection and maintenance procedures to ensure properly-functioning safety belts.

As a result of these often new awarenesses about safety belts and their use, it can reasonably be expected that persons successfully completing this unit will:

1. Understand the accident-avoidance and crash-attenuating characteristics of safety belts.
2. Act on that understanding by wearing safety belts themselves when driving and . . .
3. Urge others to do the same.

I would consider a 10% increase in safety belt usage for a period of one year following the course a realistic goal. Achieving this goal would indicate a cost-effective program—particularly when teenage, beginning drivers are the target audience. Let's look at some statistics:

- There are 125,100,000 licensed drivers²⁴.
- 22%* use belts²⁶.
- If the use rate increased from the current 22% to 80%, an additional 10,500 fatalities²⁶ and 1,038,000 injuries^{26,36} would be prevented.

10,500 deaths @ \$200,725 per death=\$2,107,612,500.00
1,038,000 injuries @ \$7,300 per injury=\$7,577,400,000.00

- Now let's zero in on a specific target group—the 15 to 24 age group, whom NHTSA⁴ believes have the greatest potential for crash reduction of any target group (i.e., young drivers, elderly, physically handicapped).

The 15 to 24 age group has²⁴:

21.8% of all licensed drivers (27,300,000)
37.3% of all fatal crashes per year (21,600)
39.4% of all crashes per year (709,200 disabling injuries)

Put another way, a sample population of 1,000,000 young drivers will have 791 fatalities per year and 25,978 disabling injuries per year.

Cost to Reach 1,000,000 Students With A Safety Belt Instructional Unit

Costs would be minimal, partly because the facilities and resources already exist and merely require more efficient utilization, assuming the 1,000,000 students can all be reached in existing high school driver education courses. Classroom facilities, instructional equipment and instructional personnel are already provided and budgeted for.

Whether or not and how to use the safety belt unit would be an administrative, curriculum decision. Most high school driver education programs currently allocate 30 hours of classroom instruction per student. The estimated time required for a well-designed safety belt unit is approximately:

1. One 45-minute classroom period.
2. 15 minutes in-car, for vehicle dynamics demonstrations.
3. Two hours of independent study, project work and assignments outside class.

* Although this may seem to be a relatively low figure, it is probably realistic when considering the total population and vehicle mix. In addition, passengers are less likely to use belts than drivers, with children even less so^{29,36}. For further discussion of current belt use, see Robertson's study, *Motor Vehicle Occupant Restraint Use and Effectiveness In Real-World Crashes*, and Stoke's paper, *Seat Belt and Shoulder Strap Use Among Urban Travelers*.

of the curriculum by deletion of less essential content (such as insurance requirements or careers in the highway transportation system).

Direct costs for the program would therefore be limited to the cost of preparing and distributing instructional materials, estimated at:

1. \$30.00 per safety belt unit kit, including 100 booklets for distribution to students.
2. \$15.00 per instructor for a one-day workshop covering content and teaching techniques (each instructor teaches approximately 100 students per year).
3. Maximum one-time cost for materials and training (assuming no sharing of materials by instructors who work together: \$450,000. Costs would be much lower for succeeding groups of students beyond the 1,000,000 figure since materials and instructor training would not need to be replicated immediately.
4. Direct cost per student: .45¢.

Cost-Benefit Hypothesis

Assuming young drivers (ages 15–24) have a current safety belt use rate of 22% (this may be a high percentage since this age group tends to have “high risk” characteristics associated with less frequent safety belt use), a 10% increase in usage as a result of exposure to the safety belt unit would demonstrate that the unit is cost-effective. This would require an increase in the use rate of course graduates from 22% to 24.2%.

22% of 1,000,000 drivers = 220,000.

24.2% of 1,000,000 drivers = 242,000.

Therefore, a 10% increase in belt usage as a result of exposure to the safety belt unit will mean that a minimum of 22,000 additional drivers will wear their belts.

Remember that this target group of 1,000,000 drivers aged 15 to 24 will have: 791 fatalities per year and 25,978 disabling injuries per year. On a strictly mathematical basis, 2.2% of those injuries and fatalities (17 fatalities per year and 572 disabling injuries per year) should theoretically be allocated to the group of 22,000 drivers who subsequently wear

belts. A realistic estimate¹¹ is that use of two-point, lap belts reduces moderate to fatal injuries (Abbreviated Injury Scale [AIS] ≥ 2) by 21.9% compared to non use. Use of three-point lap and shoulder belts reduces moderate to fatal injuries by 57.4% compared to non use.

Since high school age students and adults who are exposed to the safety belt unit can be expected to drive a variety of vehicles of varying age and belt configuration, it becomes difficult to estimate precisely what percentage of those who wear belts will wear lap/shoulder belts as opposed to lap belts only.

We do know that the percentage of vehicles with non-detachable three-point belts is increasing and that most people wearing belts in vehicles so equipped wear the entire unit. In older vehicles without non-detachable three-point belts, use of the shoulder belt portion in addition to the lap belt is much lower.

One recent study¹¹ of approximately 10,000 vehicle towaway accidents evaluated belt usage and indicated that in the sample, 63% of those wearing belts wore lap/shoulder units, while 37% of those wearing belts wore only the lap portion. Again, these percentage figures are for late model vehicles. Usage rates for lap/shoulder units will be lower in older vehicles. However, since total belt utilization itself will be lower in older vehicles and higher in newer vehicles, a weighted factor in favor of lap/shoulder unit use must be assigned to that portion of the population that wears belts.

A more realistic estimate for the total vehicle population is that of those people who wear belts, 40% wear lap/shoulder units, while 60% wear only lap belts. As more new cars are produced, these figures will improve until lap/shoulder belt usage rates for the total vehicle population approach the current usage rates for 1973–1975 vehicles.

Using the 40% lap/shoulder vs. 60% lap only figures, we can estimate an injury reduction rate for moderate to fatal injuries of 36.1% for those wearing belts. This conservative figure is based on an injury reduction rate (AIS ≥ 2) of 57.4% for the 40% wearing lap/shoulder units and an injury reduction rate of 21.9% for the 60% wearing only lap belts.

366 disabling injuries per year, instead of 572.

The annual savings for this group will thus equal:

1. 6 lives saved per year at a societal cost saved of \$1,204,350.00.
2. 206 disabling injuries prevented each year at a societal cost saved of \$1,503,800.00.

Total societal benefit: \$2,708,150.00 per year.

Total direct cost : \$450,000.00.

Cost benefit ratio : $\frac{1}{6}$.

restraints or other new technology will be implemented and in widespread use in the next six years, then it is possible to multiply the per-year societal benefit figure by a factor of six. This assumes extended belt use beyond a one year period following exposure to the safety belt unit. It is logical to predict that the habit of belt use, once acquired, will be retained in most cases, thus improving the baseline cost benefit ratio of $\frac{1}{6}$ to a maximum of $\frac{1}{36}$.

- istered as a structured learning experience. The beginning driver population found in high school driver education is an ideal target audience for a safety belt program because the younger drivers' lower than average safety belt use rates and their overinvolvement in risk-taking and collisions combine to give any increase in safety belt usage by this age group greater "payoff" than similar increases for other age groups. For similar reasons, a secondary, but still appropriate, target audience consists of high risk adult drivers who are overinvolved in collisions and violations.
2. A significant advantage of safety belt instructional programs—when compared to passive re-

grams can easily be cost effective, with a cost-benefit ratio of $\frac{1}{6}$, assuming a 10% increase in safety belt use by course participants for a period of one year following the course.

3. Increased safety belt usage rates—beyond the current rates of approximately 22%—are not only possible, but probable. Contributing factors include improvements in safety belt design, such as the Volkswagen "passive restraint system" and increases in safety belt usage rates in newer vehicles. When combined with properly-designed educational programs, their impact on safety belt usage rates will be a cumulative one.

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³² Volkswagen of America, Inc. *Rabbit. The Way People Talk About It Says a Lot About It*. Promotional brochure, 1975.

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³⁸ Scheuer, James H., Representative (New York). "Mandated Seat Belt Use." Presentation in the House of Representatives, November 13, 1975. Printed in the Congressional Record.

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ABSTRACT CITATIONS

stantially improved performance and durability, developed for automotive gasoline engines, is described. All components of the system are integrated within the distributor, and no scheduled parts, replacement or adjustment of system components is required. The requirements of system performance and durability, which guided the development of the new system, are outlined: maintenance-free operation of distributor, coil, and electronics; extended spark plug life; improved ignition of fuel mixtures; and improved reliability and life. The HEI system is described: high-voltage distribution system; ignition coil; and electronic module and magnetic pulse generator. A discussion of the operation and limitations of both breaker-operated and transistor systems explains the need for dwell time control and coil primary current regulation, new control functions resulting in reduced component size and power dissipation essential for integral design. The laboratory and field testing of the HEI system is described. In the laboratory test program, thousands of components and total systems were tested for performance and durability (tested between 500 and 5000 rpm, at 240°F, between -20°F and 225°F, and at 140°F and 70% relative humidity). A total of 1651 field test units at 38 sites across the United States have been operated over more than 50,000,000 miles. Most tests have been in severe operating service, such as taxis and police cars. It has been found that: spark plug life improved from 12,000 to 22,500 miles with the HEI; and cold-starting performance is greatly improved (more voltage provided at ignition with HEI than during running operation with a typical transistor system).

by Gerald O. Huntzinger; Gerald E. Rigsby
General Motors Corp., Delco-Remy Div.
Rept. No. SAE-750346 ; 1975 ; 12p 2refs
Presented at the Automotive Engineering Congress and
Exposition, Detroit, Mich., 24-28 Feb 1975.
Availability: SAE

HS-017 585

EPOXIES AND URETHANES--CHANGING TIMES BREED NEW PRODUCTS

New technical developments in epoxy and urethane products and processes are reviewed: replacement of MOCA and TDI in polyurethane adhesives and elastomers; solvent free epoxies (100% solids insulation resins and new epoxy powder coatings; epoxy seam filler to replace lead on passenger cars; and new high speed cure and fixturing methods (induction heating, hot air heating, radiant heat, and wellbonding). Each represents a significant advance in the area of addition resin curing agent technology and each was made necessary because recent adverse economic or legislative factors had forced a change in established manufacturing or assembly processes.

by Justin C. Bolger
Amicon Corp.
Rept. No. SAE-750345 ; 1975 ; 7p 10refs
Presented at the Automotive Engineering Congress and
Exposition, Detroit, Mich., 24-28 Feb 1975.
Availability: SAE

cal future market analysis for automobile and light commercial vehicle applications, is described. It sets a practical compromise between light weight and low cost, and embodies features not normally found in engines of this type. A newly developed combustion system complies with all likely legislation, as well as improving consumer acceptance of the diesel concept. The detail design considerations are discussed: the piston assembly, the connecting rod assembly, the cylinder block, the crankshaft, the cylinder head, the valvegear, and mechanical efficiency. The light and heavier duty engines are compared by mass and dimensions. It is found that: economy gains of the order of 30% are expected with the new design, when compared to a gasoline engine of similar displacement; and compared to the heavier duty engines this model is 10% lighter, 0.37 inches less in height, 0.98 inches shorter, much less noisy, much smoother, and 12.5% more flexible in the rated speed range. This engine is designed to meet 1977 federal standards for noise, gaseous emissions and smoke opacity. Torsional vibrations are limited by the use of low mass reciprocating and rotating parts.

by D. E. Larkinson; B. R. Jewsbury
Perkins Engines Co.
Rept. No. SAE-750333 ; 1975 ; 8p 2refs
Presented at the Automotive Engineering Congress and
Exposition, Detroit, Mich., 24-28 Feb 1975.
Availability: SAE

HS-017 587

EXPERIENCE WITH COMPREX PRESSURE WAVE SUPERCHARGER ON THE HIGH-SPEED PASSENGER CAR DIESEL ENGINE

The mode of operation of the Comrex pressure wave supercharger is described. Its general advantages and drawbacks are reported and the experience gained in practical operations on the supercharging system, using a 2.2 cubic decimeter prechamber passenger car diesel engine, is discussed. The general adaptation of the engine to the Comrex is considered: choice of the degree of supercharging; adaptation of the engine; limits in adapting the Comrex to the engine; adaptation of the Comrex; and the intake and exhaust system. The adaptation of the injection equipment (injection pump and nozzle, and governor) is described and the adaption of the engine components is discussed: cylinder head, piston, crankshaft, exhaust gas receiver, and belt drive. Graphs are used to show the results of engine tests (exhaust emissions and nonsteady-state characteristics of the engine). The installation of the engine into a vehicle is described and graphs of driving performance (when accelerating and shifting gears simultaneously and when accelerating in the individual gears), driving characteristics, and exhaust gas values are provided. It is concluded that: the Comrex pressure wave supercharging system is suited to passenger car diesel engines; the fuel consumption and exhaust emission values of the Comrex during steady-state operation correspond closely to those of a normal air diesel engine; and the high degree of supercharging necessary for reasons of cost, as well as the numerous additional pieces

by E. Eisele; H. Hiereh; H. Polz
Daimler-Benz AG., West Germany
Rept. No. SAE-750334; 1975; 12p 1ref
Presented at the Automotive Engineering Congress and
Exposition, Detroit, Mich., 24-28 Feb 1975.
Availability: SAE

HS-017 588

COMPLEX SUPERCHARGING OF VEHICLE DIESEL ENGINES

The Complex supercharging device, a gas-dynamic, pressure-wave machine for supercharging vehicle diesel engines in the 100-500 horsepower range, is discussed. The Complex uses exhaust gas energy for compressing intake air. The principle of operation, and design (casings, rotor and jacket, rotor support, drive, and cold-start valve) of the Complex are described. The performance characteristics of the device are detailed: boost characteristics, engine lug curves, altitude simulation, cold start and cleanup, engine response to load changes, acceleration smoke, and exhaust gas recirculation. The application of the Complex to an engine is discussed: Complex size and transmission ratio, injection system, Complex mounting, and low-pressure ducts. Test experience with the Complex installed in several trucks is recorded for driveability, acceleration uphill, and durability, and the possibility of using the Complex in small diesel engines is considered. Complex supercharging is found to give high torque down to less than 40% of rated speed. Almost instantaneous response combines with significant reductions in acceleration smoke. An increase in maximum compression ratio and efficiency and a wider speed range have been achieved. The endurance tests performed on the Complex engine were successful and the system has been redesigned for the smaller dimensions and adapted to production requirements.

by Peter K. Doerfler
BBC Brown, Boveri and Co., Ltd., Switzerland
Rept. No. SAE-750335; 1975; 12p 11refs
Presented at the Automotive Engineering Congress and
Exposition, Detroit, Mich., 24-28 Feb 1975.
Availability: SAE

HS-017 589

DEVELOPMENT OF A HIGH SPEED FOUR-CYLINDER DIESEL ENGINE UNDER CONSIDERATION OF THE EXISTING MACHINETOOLS EQUIPMENT FOR THE PRODUCTION OF THE GASOLINE ENGINES

The development at low cost of a light high speed diesel engine with an operating cost and driving performance comparable to gasoline engines is described. Techniques used in the manufacture of gasoline engines and diesel engine cylinder blocks are emphasized. Initial design and development investigations are discussed and the design and development of the production engine are detailed: cylinder block and bearing proportions, cylinder head, valve train and adjustment, swirl chamber, nozzle holders, cold start heater plugs, cylinder head joint, water cooling system, pistons, crankshaft and rear oil seal, and lubrication system. The performance development of

development of the engine are considered: valve bridge cracks, valve seat wear in the cylinder head, and problems during the development of the cylinder head gasket. The work has resulted in the production of the 2.1 liter diesel engine, installed in the Opel Rekord automobile. The low fuel consumption, high reliability, and good power-to-weight ratio compensate for the high initial costs and higher noise levels. The Opel diesel engine gives low hydrocarbon and carbon monoxide emissions, but nitric oxide emissions far exceed established 1978 standards

by H. Weitzel
Adam Opel AG., West Germany
Rept. No. SAE-750336; 1975; 16p
Presented at the Automotive Engineering Congress and
Exposition, Detroit, Mich., 24-28 Feb 1975.
Availability: SAE

HS-017 590

SCHEDULING INJECTION TIMING FOR REDUCTION OF DIESEL EMISSIONS

The requirements for scheduling injection timing as a function of speed and load for high-speed light-duty engines and larger diesel engines are discussed. A combined speed and load timing device developed for the CAV DPA pump is presented. Work on two passenger cars powered with swirl chamber diesel engines (a 4 cylinder and a 6 cylinder engine) initially having standard DPA pumps and later fitted with pumps incorporating the timing scheduling device is then described and discussed. The two cars gave hydrocarbon (HC) emissions above 0.41 gram per mile. In the case of the 4 cylinder engine, the development of somewhat modified fuel injection equipment incorporating the speed load timing device led to the vehicle's satisfying the emission targets for HC, nitrogen oxides, and carbon monoxide of .41, 2, and 3.4 grams per miles respectively without any alteration in vehicle noise emission or fuel economy. It is concluded that timing scheduling is essential for minimizing gaseous emissions and for obtaining engine performance which is satisfactory in other respects via visible emissions of white and black smoke, engine noise and fuel economy.

by I. M. Khan; A. C. Green
Cav Ltd., London, England
Rept. No. SAE-750337; 1975; 14p 7refs
Presented at the Automotive Engineering Congress and
Exposition, Detroit, Mich., 24-28 Feb 1975.
Availability: SAE

HS-017 591

ENGINEERING REQUIREMENTS FOR AUTOMOTIVE TEXTILES

The development of engineering material requirements for automotive textiles is discussed. To provide a durable, functional and competitive product, a textile specification and the test it employs must be based on the final item design and application, as well as the textile's composition and construction. The replacement of natural by synthetic fibers and the changes which must occur due to diminishing petroleum supplies (from which most synthetic fibers are made) are considered. Future

fibers from cellulose or other natural compounds as bases. New directions in textile developments suggested by textile manufacturers are presented: reduce the BTU energy required to produce fabrics by more finishing or by use of solution dyed fibers that require no finishing; employ lighter weight fabrics making the most efficient use of available synthetic fibers, particularly polyester; make use of more natural fibers; make use of recycled or reclaimed fibers; employ lighter weight vinyl coatings; investigate urethane coatings to replace vinyl; employ composite yarns of different fiber compositions to increase flexibility; and encourage chemical fiber producers to research other means of producing durable fibers not dependent on petroleum.

by John B. McCallum
Ford Motor Co.
Rept. No. SAE-750340 ; 1975 ; 8p 10refs
Presented at the Automotive Engineering Congress and
Exposition, Detroit, Mich., 24-28 Feb 1975.
Availability: SAE

HS-017 592

CONSERVATION OF RESOURCES--ORGANIC SURFACE COATINGS

Efforts of the automobile surface coating industry to devise new methods of production which comply with environmental and energy conservation legislation are discussed. Although the rising cost of other raw materials must be considered, the surface coating industry foresees the use of water-based topcoats and primers as both an economically and environmentally safe technique. If humidity control costs seem to be more expensive than planned, powder-based coats and new curing methods could prove to be even more efficient.

by John B. Hemwall
Immont Corp.
Rept. No. SAE-750343 ; 1975 ; 4p
Presented at the Automotive Engineering Congress and
Exposition, Detroit, Mich., 24-28 Feb 1975.
Availability: SAE

HS-017 593

PROGRAMMABLE ENERGY IGNITION SYSTEM FOR ENGINE OPTIMIZATION

An experimental ignition system with a spark having an adjustable power level and programmable arc duration is described. The system permits optimization studies of many engine parameters such as engine geometry, fuel preparation, and ignition. It uses inductive-discharge to strike the arc and, together with transformer action, sustains the arc from a single coil for any duration. Its principal features are: programmable arc duration, high arc current for full arc period, fast voltage rise, low average battery current drain, no intermediate power supply, and inductive storage. The results of electrical tests of secondary loading, available output voltage versus supply voltage, and battery drain are indicated. Limited test results (a single cylinder cooperative fuel research engine used as test engine) are presented to show the effect of arc duration on engine operation (on lean limit, charge dilution limit, and a mobile, heterogeneous mixture). It is found that extended arc duration can be of some benefit when engine operation is ignition limited.

HS-017 594

GLASS MATERIALS: 1974--1980

The material, energy, supply and transportation, and supportive technology requirements of the glass and fiberglass industry are examined and the ability of industry to meet the needs of the automotive industry through 1980 is discussed. Glass raw materials include: sand, alkali (soda ash and caustic soda), limestone, dolomite, calcare, cullet, and metals (platinum, and tin). Fiberglass requires boron compounds and clay. Secondary materials requirements are discussed: polyvinyl butyral, structural steel, and refractories. It is concluded that: the glass industries will continue to play an increasingly important role in the automotive industry; the glass industries have not been affected by materials shortages, availability and high cost of energy, and shortages of freight facilities as greatly as other industries supplying automotive manufacturers; and despite uncertainties, the glass and fiberglass industry will be able to meet the needs of the automotive industry while, at the same time, providing the supportive technology required through 1980.

by Richard F. Sperring
PPG Industries
Rept. No. SAE-750344 ; 1975 ; 8p 10refs
Presented at the Automotive Engineering Congress and
Exposition, Detroit, Mich., 24-28 Feb 1975.
Availability: SAE

HS-017 595

HITCHHIKING--A VIABLE ADDITION TO A MULTIMODAL TRANSPORTATION SYSTEM? FINAL REPORT

Social, legal, and planning data are presented from a 12-week study in 1974 by 13 students who conducted library research, interviews with public officials and four surveys: a general survey of 195 representative citizens; a police survey; current hitchhikers survey; and survey of participants (44 surveys sent) in a prototype hitchhiking system. Data were obtained on the percentage of current hitchhikers (19%), drivers who pick up hitchhikers (31%), those who have ever hitchhiked (43%) or picked up hitchhikers (52%), social characteristics, crime statistics, ways of hitchhiking, opinions on the legal status of hitchhiking, and possible increased participation if certain reforms were made. Problems that inhibit many from hitchhiking or picking up hitchhikers include: fear of crime; traffic safety; inconvenience; feelings that "it should not be done"; and fear of arrest. Recommendations were: legalization of hitchhiking; establishment of a voluntary system for registering hitchhikers; and designation of hitchhiking areas along streets and highways where cars can safely pull over and stop. A copy of each type of survey questionnaire is appended along with a summary of European hitchhiking laws and automobile guest laws.

HS-017 596

HIGHWAY TRAVEL FORECASTS. FINAL REPORT

The results of a study to reevaluate national highway travel forecasts in light of such factors as declining birth rates, possible saturation of vehicle ownership, and fuel constraints are reported. Highway travel is compared to travel by all other modes for the years 1940 to the present day (1970-1974). Results indicate that highway travel can be expected to increase at an annual compound rate of 2 to 3% per year until 1990 as compared to an average annual growth of 4.6% for the last 20 years. Travel projections are based on anticipated increases in population, licensed drivers, vehicles, and personal income. It is concluded that the reduced travel growth rate would have occurred even without the fuel shortage due to the decreasing rate of persons entering the driving age population as a result of the decline in births since the late 1950's. Even with fairly severe constraints on fuel the travel projections appear reasonable, assuming continued increases in the fuel efficiency of the vehicle fleet using presently available technology.

by Gary Maring
Federal Hwy. Administration, Office of Hwy. Planning, 400
7th St., S.W., Washington, D.C. 20590
1974 ; 69p 16reft
Availability: NTIS

HS-017 597

BLOOD-ALCOHOL IN ROAD FATALITIES BEFORE AND AFTER THE ROAD SAFETY ACT, 1967

Coroners' reports for traffic fatalities (representing 1/4 of all drivers and 1/5 of all pedestrians and passengers killed in England and Wales for the period) were examined to provide information on blood alcohol levels (BACs) before and after the introduction of the Road Safety Act of 1967 (making an offense of driver BACs in excess of 80 milligrams per 100 milliliters of blood). Factors considered in the five year study include the age of the driver, the time of year, time of day and day of week, and road users other than drivers (bicyclists, passengers, and pedestrians). It was found that prior to the Act, in 1966/67, 37% of driver fatalities had been drinking and 25% exceeded the level to become the legal limit. These proportions decreased immediately after the introduction of legislation to 26% and 15% respectively, but, in subsequent years until 1971, returned to the pre-legislation values. It was also found that: there were marked age differences in the level of drinking and the effects of the Act; drivers in the 20-29 age group had the highest BACs exceeding the legal limit in recent years; and proportions of driver fatalities exceeding the limit were highest between 10 p.m. and 4 a.m., particularly on Saturday nights. Although the Act did not apply to road users other than drivers, there were reductions in the level of drinking among passengers and bicyclists, though not among pedestrians.

HS-017 598

THE KENYA ROAD TRANSPORT COST STUDY: RESEARCH ON VEHICLE OPERATING COSTS

An investigation undertaken in Kenya to examine the effects of various road, vehicle, and environmental parameters on some components of vehicle operating costs is described. An experimental study of vehicle speed and fuel consumption was conducted. Parameters included: environmental (rainfall and altitude); road geometry (horizontal curvature, vertical curvature, and width); surface type (asphaltic concrete on crushed stone base, bituminous surface dressing on stabilized soil bases less than 3 years old and more than three years old, gravel surfaced roads, and earth roads); and surface condition (roughness, looseness, moisture depth, and rut depth). A Ford Cortina estate car with a 1.6 liter, 4 cylinder gasoline engine, a Land Rover with a 2.6 liter, 6 cylinder gasoline engine, and a Bedford J4LC5 truck with a 5.4 liter, 6-cylinder diesel engine were run on 95 two-kilometer test sections of which 49 were paved, 42 gravel, and 4 dirt. A road user survey was undertaken to derive a set of relationships between the components of vehicle operating cost, other than fuel, and road and vehicle parameters using data obtained from commercial vehicle operators (of passenger cars, light goods vehicles, medium and heavy goods vehicles, and buses). The data collected were also used to calibrate and extend the fuel consumption relationships derived in the experimental study. Relationships derived from the study have been incorporated in the Road Transport Investment Model.

by H. Hide; S. W. Abaynayaka; I. Sayer; R. J. Wyatt
Transport and Road Res. Lab., Overseas Unit, Crowthorne,
Berks., England
Rept. No. TRRL-LR-672 ; 1975 ; 112p 15reft
Availability: Corporate author

HS-017 599

NORTH CAROLINA ACCIDENT DATA, JANUARY 1, 1974 TO DECEMBER 31, 1974

All legally reportable traffic accidents (those involving a fatality, personal injury, or over \$200 property damage) not occurring totally on private property in North Carolina during 1974 are described in an accident dictionary format. The variables recorded by the Division of Motor Vehicles describing the accident, the first two vehicles involved, their drivers, and occupants are defined. For each variable value, the meaning, frequency of occurrence and the percent of total population is given. The proper usage of the dictionary is explained.

National Driving Center, 255 Engineering Annex, Duke Univ.,
Durham, N.C. 27706
1975 ; 85p
Prepared for the State of North Carolina in cooperation with the North Carolina Div. of Motor Vehicles and the North Carolina Governor's Hwy. Safety Prog., under Proj. No. 110-75-001. See also HS-017 600, HS-017 601 (vol. 1), and HS-017 602 (vol. 2).
Availability: Corporate author, \$5.00

Those North Carolina drivers identified through a medical evaluation process as of December 31, 1974, are described in a dictionary format. Variables recorded by the Division of Motor Vehicles describing these drivers and their driving experience are defined. Violations and accidents as well as other counts of actions against an individual's driving record are presented for both the last five years and the total recording period, as all records except those with serious violations or accidents are purged after five years. Those with a number of violations or medical history, however, are kept indefinitely and, therefore, statistical comparisons are more valid when made on the five year grouping. For each variable value, the meaning, frequency of occurrence, and the percent of total population is given. A guide to dictionary usage is also provided.

National Driving Center, 255 Engineering Annex, Duke Univ., Durham, N.C. 27706
1975 ; 120p

Prepared for the State of North Carolina in cooperation with the North Carolina Div. of Motor Vehicles and the North Carolina Governor's Hwy. Safety Prog., under Proj. No. 110-75-001. See also HS-017 599, HS-017 601 (vol. 1), and HS-017 602 (vol. 2).

Availability: Corporate author, \$5.00

HS-017 601

NEUROLOGIC DISORDERS, CARDIOVASCULAR DISEASE AND MOTOR VEHICLE OPERATION. VOL. 1. REPORT, OCTOBER, 1975

Summaries and comments on an extensive volume of literature pertaining to licensing standards, medical and driving research on cardiovascular and neurological diseases and vehicular operation are presented. Also, the driving patterns of 12,101 North Carolina (N.C.), drivers suffering from neurological and cardiovascular disorders are analyzed and compared to a random sample of 20,698 N.C. drivers. It was revealed that: drivers with cardiovascular and neurological diseases differ significantly in their incidence of personal injury and property damage violations; the cardiovascular group shows no significant difference from the control group; the neurologically impaired drivers have personal injury accidents at a rate of 2.3 times that of the control group and a property damage accident rate 1.5 times that of the controls; and both disabled groups show a decreased incidence in alcohol related violations and appear no different from controls with regard to speeding and other common violations. It is suggested that only a small and unusually good portion of the impaired drivers may be reporting themselves as impaired at the time of examination. Also, their exposure is less than the normal driving population, thus increasing the significance of their accident rates.

by Frank A. McGrew; Andrew G. Wallace; C. Wm. Erwin; Frank E. Muth; Ng. Khye Weng
National Driving Center, 255 Engineering Annex, Duke Univ., Durham, N.C. 27706
1975 ; 132p 129refs

Prepared for the State of North Carolina in cooperation with the North Carolina Div. of Motor Vehicles and the North Carolina Governor's Hwy. Safety Prog., under Proj. No. 110-

HS-017 602

NEUROLOGIC DISORDERS, CARDIOVASCULAR DISEASE AND MOTOR VEHICLE OPERATION. VOL. 2. APPENDICES, OCTOBER 1975

Driver medical standards and procedures of the Greyhound Bus Lines and the Bureau of Motor Carrier Safety are given, as well as driver licensing guidelines for medical advisory boards, relating functional ability to class of vehicle, for the Public Health Service. Topics dealt with include: blood pressure, heart, cardiovascular function, cardiac pacemakers, hypertensive vascular disease, vascular disease affecting the extremities, and vascular aneurysms. Also provided are univariate frequency analyses of selected variables in the North Carolina driver medical file for drivers with cardiovascular and neurological diseases.

National Driving Center, 255 Engineering Annex, Duke Univ., Durham, N.C. 27706
1975 ; 235p

Prepared for the State of North Carolina in cooperation with the North Carolina Div. of Motor Vehicles and the North Carolina Governor's Hwy. Safety Prog., under Proj. No. 110-75-001. See also HS-017 599, HS-017 600, and HS-017 601 (vol. 1).

Availability: Corporate author, 2 vol. set, \$20.00

HS-017 603

COLLISION BEHAVIOR OF YOUNG DRIVERS. IMPACT OF THE CHANGE IN THE AGE OF MAJORITY

A comparison is presented of the number of automobile accidents experienced by 16, 17, 18, 19, 20, and 24 year old male drivers in London, Ontario, before and after (January 1968-June 1973) the reduction in the legal age for drinking and purchasing alcoholic beverages from 21 to 18 (July 1971). Police accident reports were examined for relevant data on: age and sex of the driver, year of the collision, time of day, and driver condition. It was found that, among other things, for 18-year-olds alcohol-related collisions increased on a 2-year standardized basis by 61, while total collisions increased by 256. The fact that alcohol-related crashes increased among the comparison group of 24-year-olds as well suggests that there was more drinking generally. All factors considered, it is concluded that about 116 accidents would not have taken place if the alcohol-purchasing age had not been lowered and this constitutes a major effect (58 collisions per year in a population of 20,000).

by Paul C. Whitehead; John Craig; Nanci Langford; Carol MacArthur; Bruce Stanton; Roberta G. Ferrence
Publ: Journal of Studies on Alcohol v36 n9 p1208-23 (Sep 1975)

1975 ; 14refs

Revision of a paper presented to the 6th International Conference on Alcohol, Drugs and Traffic Safety, Toronto, Sep 1974. Sponsored by the Canada Council of Young Drivers.
Availability: See publication

The results of research into the feasibility of seismic vehicle sensing (detection, counting, and identification of vehicles on the basis of ground vibrations) are described. A seismic sensor enables detection, not of vehicle presence, but of vehicle movement. A short review of the concepts and techniques of seismic vehicle detection is provided and the operation of a vehicle counter is described. It is concluded that such simple passage detectors and vehicle counters are feasible but the extreme unpredictability of the parameters involved in seismic propagation make more elaborate functions, particularly automatic vehicle identification, difficult to achieve.

by C. E. Pykett

Publ: Traffic Engineering and Control v16 n7/8 p317-9, 323

(Jul/Aug 1975)

1975 : 2refs

Availability: See publication

HS-017 605

INJURIES TO CHILDREN INVOLVED IN ROAD ACCIDENTS

Results are presented of two investigations into traffic accidents involving children to determine possible methods of child protection. Data were gathered from: accident casualty/hospital patient interviews; questionnaires submitted to the purchasers of child restraints; and national traffic accident statistics of England. In order to make valid comparisons between children and adults, only passenger casualties were considered in the study. The following factors were investigated: children in cars (variation of injury incidence with age; and distribution of injuries to child car occupants); restraint systems for children (design requirements and efficacy of current restraint systems); and children as pedestrians (the variation in child pedestrian injury incidence with age, the distribution of injuries to pedestrians, and vehicle modification to reduce injuries to child pedestrians). It was found that: in 1972 in England, about 2400 children under the age of 15 were killed or seriously injured in cars; and in the same period about 11,500 child pedestrians were killed or seriously injured. It is concluded that: children in cars are significantly safer in rear than in front seats; for children, both as car occupants and as pedestrians, the most critical injuries are those to the head; child restraint systems need to be designed to suit the child's body; there is evidence that correctly designed child restraint systems are effective in reducing injuries in all directions of impact; and for child pedestrians, retention on the car bonnet after impact shows a possible means of preventing final impact with the road surface and of reducing injuries from this cause.

by R. W. Lowne

Transport and Road Res. Lab., England

1974 : 11p 12refs

Presented at the International Meeting on Biomechanics of

Trauma in Children, Lyon, France, Sep 1974.

Availability: Reference copy only

A study, begun in February 1971, of all traffic accident victims admitted to Odense University Hospital, Odense, Denmark (population 230,000), about 3,000 people per year, is reported. The investigation includes: time and place of accident; use of protective measures; description of lesions by type and region; consideration of age, sex, and occupation of victim; and the codified police description of the accident type. The increase of incidence in traffic accidents involving children is shown by comparing one year of the 1971 study with a previous study conducted in 1959-60. During the 12-year period, the number of children hit by automobiles doubled and the number of injured automobile child passengers quadrupled. Various age groups injured in traffic accidents are classified by type of conflict. Lesions suffered by child victims are classified by area on body, severity, and age of victim. The following accident factors are discussed: age variation, accident situations, description of the adult counterpart, geographical analysis, the effect of restrictions on driving (oil crisis restrictions on driving and driving speed), and the type of conflict. Analysis of the time-of-year, day-of-week and 24-hour variation showed that daylight, warm-weather, Saturday-Sunday-Monday, around 5 p.m. were the conditions of the most child accidents. It is concluded that: steps should be taken to improve children's traffic behavior at the ages 2-3 years as pedestrians and 3-4 years as bicyclists; children are not mature pedestrians until they are 10-11 years old or mature bicyclists until 14-15 years; and most accidents between children and automobiles take place at uncontrolled crossings on medium sized and suburban roads.

by Erik L. Nordentoft

Odense Univ. Hosp., Denmark

1974 : 18p 7refs

Presented at the International Meeting on Biomechanics of

Trauma in Children, Lyon, France, Sep 1974.

Availability: Reference copy only

HS-017 607

TRAUMA TO CHILDREN AS CAR OCCUPANTS

A review is made of field data available on injuries sustained by child car occupants in accident situations. A sample of 103 accident-involved vehicles containing 402 occupants of whom 178 were children under 15 was selected for study from at-the-scene and retrospective in-depth accident investigations conducted by the Accident Research Unit at Birmingham University, England. Vehicle occupancy is analyzed according to numbers and age and seating position, and injuries to unrestrained children are discussed. It was found that: 50% of all injured children less than one year old were seated on the lap of a front seat occupant; a high proportion of children aged 1-5 years occupied rear seats (70%); and there is a great occurrence of head injury in children due to their big head to body weight ratio. A series of tests, evaluating the performance of child seats and harnesses for 9-18 kilogram children (1-5 year olds) in frontal impacts at 20 mph, are reviewed. Five accident case studies are presented to illustrate the performance of child restraints (2 side impacts, one out-of-control complex collision, one collision with a tree, and a severe frontal impact with a heavy goods vehicle). It is concluded that: younger children are less likely to be injured than older children; the head is most frequently injured regardless of age; as age increases head injuries decrease and face injuries increase; upper and

by a lap diagonal belt; for children weighing 9-18 kilograms the shell type auxiliary seat anchored to the vehicle at four points and provided with an integral child harness is the most effective system; and the structure of a child's pelvis requires either a relatively steep lap belt angle (45-60°) or the provision of a crotch strap to ensure correct location of the belt.

by S. J. Ashton; G. M. Mackay; P. F. Gloyns
University of Birmingham, Dept. of Transportation and
Environmental Planning, England
1974 ; 18p 28refs
Presented at the International Meeting on Biomechanics of
Trauma in Children, Lyon, France, Sep 1974.
Availability: Reference copy only

HS-017 608

INFANT AND CHILD ANTHROPOMETRY

A comprehensive review of the child and infant anthropometry data available to date is presented. A three-year (1972-75) nationwide multidisciplinary anthropometric study of children up to 12 years old, conducted by the University of Michigan, is discussed. At the time of publication, 41 different measurements had been taken of over 3000 children, representative of the U.S. population. Two digital field measurement systems were developed and are explained. A number of specialized infant and child measurement devices were designed and used with pressure transducers to provide a new basis for more accurate and precise measurement of body dimensions than has been possible with previous standard anthropometric instruments. The information already collected has provided a basis for an improved Federal safety standard for infant crib slat width.

by Richard G. Snyder; Martha L. Spencer; Lawrence W. Schneider; Clyde L. Owings
University of Michigan, Ann Arbor, Michigan
1974 ; 10p 28refs
Presented at the International Meeting on Biomechanics of Trauma in Children, Lyon, France, Sep 1974. Work supported by the Children's Hazards Div., of the Food and Drug Administration, and by the Consumer Product Safety Commission.
Availability: Reference copy only

HS-017 609

DESIGN CONSIDERATIONS FOR FULL-SIZE, FRONT-WHEEL-DRIVE VEHICLES

A progress report on the marketing, evolution, and design considerations for full-size, front-wheel drive cars is presented. Applications of front-wheel drive, since the Oldsmobile Toronado in 1966, are discussed. Design refinements and improvements (brakes, final drive, and drive axles) are described along with changes made to meet marketing requirements (styling, size, structural, suspension, and weight changes). Design differences between front-wheel drive and rear-wheel drive cars are emphasized: power train (general arrangement, noise isolation, drive-axle smoothness, and power train cooling); chassis (traction, throttle-steering control interaction, front suspension and steering system, rear suspension, tires, power train mounting, braking system, wheels, overall ride and handling, and independent rear suspension); and body dif-

by Donald L. Nordeen; Richard C. Manwaring; Dennis E. Condon
General Motors Corp., Oldsmobile Div.
Rept. No. SAE-750014 ; 1975 ; 27p 3refs
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.
Availability: SAE

HS-017 610

SHOULDER-BELT-FORCES AND THORAX INJURIES

To investigate the tolerance limit of the human thorax in frontal collisions with a shoulder harness, tests were carried out on 51 male and female cadavers from 12 to 82 years of age wearing a 3-point-belt with automatic retractor, a diagonal-shoulder-belt with automatic retractor combined with a kneebar, or a diagonal-shoulder-belt, knee-belt, with automatic retractor, belt-force limiter, and preloading device. Forty-four tests were conducted with crash velocities of 50 kilometers (km) per hour; 6 tests with velocities of 64 km per hour; and one test with a crash velocity of 80 km per hour. Locations of thoracic deformations are analyzed in detail. It was found that: enlargement of the bearing surface of the belt can reduce injury severity; on the right side, fractures of the upper six ribs predominated and on the left side fractures concentrated in the middle thorax area; most rib fractures were shear fractures; in 7 out of the 51 cases, the thoracic spine was broken; the more often the thorax skeleton was instabilized through fractures, the more frequent were injuries of the internal organs; the wearing of shoulder harnesses can protect younger occupants (up to 30 years) from having thorax injuries when crashing against a rigid wall at 50 km per hour; and the injury severity risk will increase progressively with age.

by Dimitrios Kallieris; Rainer Mattern
University of Heidelberg, Inst. of Forensic Medicine, West Germany
1974 ; 14p 3refs
Presented at the Proceedings of the International Meeting on Biomechanics of Trauma in Children, Lyon, France, Sep 1974.
Availability: Reference copy only

HS-017 611

POSSIBLE EFFECTS OF AIRBAG INFLATION ON A STANDING CHILD

The influence of the different airbag inflation pulses on the kinematics and possible mechanisms of injury to a living body (anesthetized pigs weighing 14-15 kilograms) in the standing position under automobile collision conditions was investigated. Three high-speed cameras recorded results. In an upright position in a rear-facing child seat, the animals were able to withstand a simulated car-barrier impact at 30 mph without any sign of injury. When suspended in a vertical position with their right side 4-6 inches from the airbag outlet area and subjected to an acceleration pulse with a peak of 12 g and a velocity change of 17.5 mph the animals were injured whether or not the airbags were inflated with any of the inflation pulses. Injury severity was rated from severe to fatal on the abbreviated injury scale. Two types of injuries were seen: tears in the liver and large bleeding in the heart and lungs. It is concluded that: an out-of-position child passenger 3-6 years

the air blast erect closely during its early phase of deployment is so easily influenced in its direction that it is difficult to obtain reproducible results.

by Bertil Aldman; Ake Andersson; Olov Saxmark
Chalmers Univ. of Technology, Dept. of Traffic Safety; A. B. Volvo, Goteborg, Sweden
1974; 24p 6refs
Presented at the International Meeting on Biomechanics of Trauma in Children, Lyon, France, Sep 1974.
Availability: Reference copy only

HS-017 612

CHILD RESTRAINT SYSTEMS. RESULTS FROM FRONTAL IMPACT TESTS AND PROPOSALS FOR COMPLIANCE TEST PROCEDURES

Frontal impact simulations with 25 different types of child restraint systems were made with Alderson 3 and 6 year old anthropometric dummies. Impact speed was 50 kilometers per hour and deceleration levels were 15-20 g. Electrical measurements were made of dummy head and chest accelerations, sled acceleration, and forces acting on the restraint systems. High-speed photography was also used. The most significant difference among various types of systems was found to be that the resultant head acceleration and hyperflexion of the neck are considerably lower with rearward facing seats than with forward facing seats, cushions, shells, and harnesses. It is proposed that, when using the described test methods, the following main performance criteria should be met: a maximum resultant head acceleration of 50g and a maximum vertical head acceleration of 20g. This implies that, among the systems existing today, only rearward facing seats can be approved. Behavioral studies and experience from the 100,000 rearward facing seats used in Sweden confirm that this is a practical and usable design concept for a child restraint system.

by Thomas Turbell
National Swedish Road and Traffic Res. Inst., Drottning Kristinas Vag 25, S-114 28 Stockholm, Sweden
1974; 10p 12refs
Presented at the International Meeting on Biomechanics of Trauma in Children, Lyon, France, Sep 1974.
Availability: Reference copy only

HS-017 613

EVALUATION OF CURRENT PRODUCTION AND PROTOTYPE CHILD RESTRAINT SYSTEMS IN THE USA

The protection potential offered by various production and prototype child restraint systems is investigated. A three-year-old size anthropometric dummy (37.5 inches high, and 32 pounds in weight) was used in tests conducted on an unsupported bench seat mounted on a test rig duplicating the occupant compartment in a full size 4 door sedan. The dummy was instrumented with triaxial accelerometer packs in the head and chest and high-speed films were taken of each test. The test configuration employed in the side impacts for this study represents the most severe conditions which may result from a real automobile side collision. The restraint system was installed on a bench seat nearest the impact point. If the system had been installed in the middle of the seat or on the side op-

posed to a lesser extent, the front impacts was due in part to deflection of the adult car seat back which allowed the child restraint system to travel further than it would have, had the seat back been more rigid.

by R. L. Stalnaker; J. W. Melvin
University of Michigan, Ann Arbor, Mich.
1974; 13p 13refs
Presented at the International Meeting on Biomechanics of Trauma in Children, Lyon, France, Sep 1974.
Availability: Reference copy only

HS-017 614

AUTOMOTIVE ENERGY EFFICIENCY PROGRAM. STATUS REPORT

The direction, progress, results, and application of studies completed or underway and the future plans of the Automotive Energy Efficiency Program (AEEP) of the Department of Transportation (DOT) are summarized. The major fuel economy studies of the AEEP (of the potential for motor vehicle fuel economy improvement, and of automobile fuel economy technology state-of-the-art) are described, followed by detailed results generated within the two subprograms: automotive component evaluation and testing (of engines, fuels, energy storage, transmissions, tires, aerodynamics effects, weight reduction, truck fuel economy state-of-the-art, and the 1973-1974 fuel crisis); and assessment of energy efficient vehicles in the highway system (automobile manufacturing assessment, vehicle systems integration, vehicle/highway systems analysis, and requirements analysis). The applications of AEEP results by DOT and other agencies in addressing the motor vehicle fuel economy issue are discussed and the planned program accomplishments for 1975 and 1976 are considered. Major interfaces of the AEEP with other Federal agencies, the automotive industry, the academic community, professional societies and other interested groups are also discussed.

Department of Transportation, Office of the Assistant Secretary for Systems Devel. and Technology, Washington, D.C. 20590
1974; 66p 38refs
A rept. to the Appropriations Com. of the House of Representatives.
Availability: Corporate author

HS-017 615

REDUCTION OF THE AERODYNAMIC DRAG OF TRUCKS. [PROCEEDINGS OF] CONFERENCE/WORKSHOP HELD AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY, PASADENA, 10-11 OCTOBER 1974

Various projects aimed at understanding and reducing the aerodynamic drag of trucks are presented. Because 7% of the total energy consumed in the United States (U.S.) is used to overcome the air resistance of road vehicles, any reduction in drag would be very energy and cost-beneficial. Projects presented include: model tests of drag and spray effects of aerodynamic modifications to present vehicles; ducted trailers for semi-trucks; an assessment of drag reduction techniques based on observations of flow past two-dimensional tractor-

analytical investigation of truck aerodynamics; a feasibility study of various truck drag reduction devices; and a truck drag reduction program at the University of Oklahoma. Also discussed are: a tractor-mounted, air deployable, aerodynamic drag reduction system; a field experience report on drag reduction of a nose cone; the development of the Ryder truck; drag and fuel saving evaluation techniques; and drag reduction for present and 1980's vehicles.

by P. B. S. Lissaman, ed.

Rept. No. PB-242 250 ; 1974 ; 187p refs

Sponsored by the Res. Applied to National Needs Prog. of the National Science Foundation and the Dept. of Transportation. Includes HS-017 616-HS-017 629.

Availability: NTIS, \$7.50; National Science Foundation RANN Document Center, 1800 G St., N.W., Washington, D.C. 20550

HS-017 616

MODEL TESTS OF DRAG AND SPRAY EFFECTS OF AERODYNAMIC MODIFICATIONS TO PRESENT VEHICLES

Wind tunnel tests were conducted using a 1/25 scale model of an International Harvester tractor with an 184 inch wheelbase and a Fruehauf F13 40 foot refrigerator van in a test section 4 1/2 feet wide, 3 feet high and 5 feet long of a 400 horsepower single-return conventional wind tunnel. Add-on devices were individually and in combination added to the basic model and comparative drag coefficients determined. In addition to drag, ground-plane flow phenomena, as indicated by approximate half-plane tufting, was observed and ground-plane pressures were measured by means of 277 surface pressure taps covering more than the model length and more than half the model width. Add-on devices included an airfoil trailer nose, an air dam bumper, and a deflector tray. The model and configuration changes were tested at a nominal 80 mph. It was found that the airfoil nose alone is not very effective; the deflector tray alone was effective in alleviating horseshoe vortex around the front of the trailer and helped create a somewhat stationary stagnation region in the gap, forcing more air over the trailer; a combination of the deflector-tray and an airshield on the roof of the tractor produced an 11% reduction in drag coefficient; and the deflector tray eliminated the intense horseshoe vortex around the lower level of the trailer front.

by George M. Palmer; James B. Amy

Purdue Univ., West Lafayette, Ind.

Publ: HS-017 615, Reduction of the Aerodynamic Drag of Trucks, Pasadena, Calif., 1974 p1-8

1974

Presented at a conference/workshop held at California Inst. of Tech., Pasadena, 10-11 Oct 1974.

Availability: In HS-017 615

HS-017 617

DUCTED TRAILERS FOR SEMI-TRUCKS (OVERCOMING AERODYNAMIC DRAG BY WAKE ENERGIZATION)

A modification to semi-truck trailers is suggested which eliminates the separation bubble on top of the trailer without the requirement of an aerodynamic vane. This entails the ducting of high pressure air into the wake of the truck. A 1/25

scale model of a tractor-trailer model tested included a 6 inch high duct running the length of the trailer (one had duct even with the front of the trailer, and the other had a scaled 3 foot overhang in front of the trailer). It was found that: the overhanging duct modification in a no-cross wind situation has the potential of decreasing aerodynamic drag of a semi-truck by almost 50% (a 25% reduction in fuel consumption at 50 mph); and in a cross-wind situation the ducted configuration will still be effective since it will still add mass to the wake.

by Harold R. Jacobs; Richard Van Winkle

University of Utah, Salt Lake City, Utah

Publ: HS-017 615, Reduction of the Aerodynamic Drag of Trucks, Pasadena, Calif., 1974 p9-13

1974 ; 8refs

Presented at a conference/workshop held at California Inst. of Tech., Pasadena, 10-11 Oct 1974.

Availability: In HS-017 615

HS-017 618

AN ASSESSMENT OF DRAG REDUCTION TECHNIQUES BASED ON OBSERVATIONS OF FLOW PAST TWO-DIMENSIONAL TRACTOR-TRAILER MODELS

A study of the steady flow of fluid about two-dimensional, 1/32 scale models of tractor-trailer combinations, carried out on a 2 foot wide, one inch deep flow table, is described. Flow patterns were made visible with the use of dye injected upstream of, and adjacent to, the models tested. Forebody drag, recognized as being the major contributor to total drag, can be practically reduced by rounding forward corners, and by utilizing flow detectors to optionally fair the separated flow passing from the tractor to the trailer. Increased drag due to yaw results principally from flow separation on the leeward side of the vehicle, and from a cross-flow through the gap separating the tractor from the trailer. The effect of the cross flow can be reduced or eliminated by the placement of suitable restrictions in the gap. Although no conventional modification could be found that would maintain an unseparated flow on the leeward side of the vehicle to the maximum yaw angle of interest, such was shown possible through the application of boundary layer control techniques. Boundary layer control also appeared effective in eliminating the drag due to cross flow.

by Frank T. Buckley, Jr.; Colin H. Marks; William H.

Walston, Jr.

University of Maryland, College Park, Md.

Grant NSF-SIA74-14843

Publ: HS-017 615 Reduction of the Aerodynamic Drag of Trucks, Pasadena, Calif., 1974 p15-31

1974 ; 10refs

Presented at a conference/workshop held at California Inst. of Tech., Pasadena, 10-11 Oct 1974.

Availability: In HS-017 615

HS-017 619

NEW ROAD TEST TECHNIQUE AND RESULTS FOR TRACTORS EQUIPPED WITH WIND DEFLECTORS

A new road test technique for measuring the fuel consumption of highway trucks is described. The method (a matched-pair technique, running two tractor-trailers simultaneously) closely simulates commercial over-the-road operation yet is able to

90% confidence level. Two tractors with and without a wind deflector in combination with a trailer having large 19 inch, 45° chamfer corners were used. Each truck was run through four 30-mile legs on an interstate highway. The drivers, both experienced, were instructed to drive normally, maintaining a 58 mph speed limit, with at least an eighth of a mile between them. Following and leading roles were switched so that each truck followed half the time and led half the time. A chase car equipped with an odometer wind direction vane recorded wind speed and direction. It is concluded that: the matched pair design is a statistically efficient test placing little constraint on the drivers' selection of velocity trajectory; and the matched pair design will also be very efficient for large values of atmospheric wind. Wind deflector type drag reducing equipment is shown to be capable of producing 16% plus or minus 7% fuel savings results.

by Selden Saunders; Bill Jensen
Rudkin-Wiley Corp., Stratford, Conn.
Publ: HS-017 615 Reduction of the Aerodynamic Drag of Trucks, Pasadena, Calif., 1974 p33-46
1974 ; 2refs
Presented at a conference/workshop held at California Inst. of Tech., Pasadena, 10-11 Oct 1974.
Availability: In HS-017 615

HS-017 620

DEVELOPMENT OF A DRAG-REDUCING DEVICE FOR TRACTOR-TRAILER RIGS: FROM WIND TUNNEL TO OPERATIONAL VEHICLE

Wind tunnel controlled road tests and in-service road tests were conducted to develop and evaluate Blair-Leffler vanes, aerodynamic drag reducing devices for tractor-trailer rigs. Wind tunnel tests were conducted in a 7 x 10 foot tunnel using 1/8 scale models with 90° air deflection vanes and the controlled road tests utilized a full-scale rig (13 x 40 foot trailer with 72 inch gap to the 290 horsepower tractor) with 60° vanes instrumented to provide fuel mileage at cruising speeds and drag evaluation from coastdowns. In-service road tests were carried out by measuring fuel usage during more than 30,000 miles of freight hauling operations. The wind tunnel and controlled road tests indicate fuel mileage improvements with the vanes of about 5% at constant speeds. In-service road tests showed improvements of 3 to 6%. No service or maintenance problems were encountered with the vanes installed on an operational vehicle.

by W. H. Wentz, Jr.
Wichita State Univ.
Publ: HS-017 615, Reduction of the Aerodynamic Drag of Trucks, Pasadena, Calif., 1974 p47-53
1974 ; 3refs
Presented at a conference/workshop held at California Inst. of Tech., Pasadena, 10-11 Oct 1974.
Availability: In HS-017 615

HS-017 621

AN EXPERIMENTAL AND ANALYTIC INVESTIGATION OF TRUCK AERODYNAMICS

A program to develop streamlined truck cabs, focused on truck-automobile interactions and based on efforts initiated in 1971, is described. The effort to translate aerodynamic con-

gy crisis. Economic analysis showed that significant reduction in the aerodynamic drag of trucks would produce corresponding fuel savings. Wind tunnel tests, using 5% scale model of 40 foot vans with a cab-over-engine (COE) tractor design, two conventional tractors, and five advanced designs, confirmed this potential for fuel savings. Fleetowner acceptance of the designs plus their interest in achieving a competitive edge in today's market emphasized the need for incorporating the new shape concepts into modification for contemporary vehicles. A second series of wind tunnel tests addressed the modification approach. The new tractor design shapes resulted in a drag reduction of 30-65% and a fuel reduction of 20-40% depending on vehicle speed and weight, in the first wind tunnel testing. After design modifications to the COE and conventional tractors, drag was reduced by 25-30%. Photographs of the various advanced design models are provided.

by Paul T. Bauer; Ronald A. Servais
Creative Engineering Consultants and Assocs., 4048 Eckworth Dr., Bellbrook, Ohio 45305
Publ: HS-017 615, Reduction of the Aerodynamic Drag of Trucks, Pasadena, Calif., 1974 p55-61
1974 ; 13refs
Presented at a conference/workshop held at California Inst. of Tech., Pasadena, 10-11 Oct 1974.
Availability: In HS-017 615

HS-017 622

AERODYNAMIC DRAG REDUCTION TESTS ON A FULL-SCALE TRACTOR-TRAILER COMBINATION WITH SEVERAL ADD-ON DEVICES.

Results from a program to assess the performance gains on a cab-over-engine (COE) tractor-trailer combination due to the addition of different low cost drag reduction devices are discussed. Tests were conducted at speeds from 30 to 65 mph, and ambient pressures, temperature, and wind velocity and direction were recorded. The five devices, mounted either on the top of the tractor, the front of the trailer, or across the gap, are illustrated. It was shown that moving the trailer forward from 62 inches to 40 inches reduced the aerodynamic drag for the baseline configuration approximately 10% at zero wind conditions. The maximum reduction realized from an add-on device was 24% for the rear trailer position (62 inches) at zero wind conditions. Some add-on devices provided only small reductions in drag. Limited data obtained for some of the devices showed that their ability to decrease drag was reduced by the presence of crosswinds. Flow visualization photographs for the baseline configuration and for configurations with the add-on devices are provided.

by Lawrence C. Montoya; Louis L. Steers
NASA Flight Res. Center, Edwards, Calif. 93523
Publ: HS-017 615, Reduction of the Aerodynamic Drag of Trucks, Pasadena, Calif., 1974 p63-88
Rept. No. NASA-TM-X-56028 ; 1974 ; 7refs
A cooperative study between the NASA Flight Res. Center and the DOT Transportation Systems Center. Presented at a conference/workshop held at California Inst. of Tech., Pasadena, 10-11 Oct 1974.
Availability: In HS-017 615

A multi-facility road test and 1/10 scale wind tunnel program have been conducted to evaluate the effectiveness of air vanes and other devices to reduce the air drag of large trucks and thereby improve the energy efficiency of cargo vehicles. Road tests were conducted at 55 mph with a 20 foot box-van truck (unloaded), a conventional tractor-40 foot trailer (loaded), and a cab-over-engine (COE) 45 foot trailer (loaded). With an air vane located at the top roof edge, fuel savings from 1.1 gallons per hundred miles (gphm) to 2.0 gphm were recorded for runs on freeway courses with a heavy duty test track. The van-truck was also configured with two additional air vanes at the side vertical edges. This resulted in a 2.3 gphm savings. It was also determined that non-protruding air vanes, cab deflector-air vane combinations, and simple, leading edge fairings are drag reduction concepts of some effectiveness. A drag-free sun visor for the COE was also developed. Minimal results were obtained with air dams and belly-pans intended to improve the air flow between the truck underbody and the roadway. Air vanes and small extended spoilers mounted at the rear of the models provided only 1-2% drag reduction. Schematic illustrations of air vane designs and photographs of the model and real trucks in various test configurations are provided.

by Jeffrey W. Kirsch; William H. Bettes
Science and Software, La Jolla, Calif. 92037; California Inst. of Tech., Pasadena, Calif. 91109
Publ: HS-017 615, Reduction of the Aerodynamic Drag of Trucks, Pasadena, Calif., 1974 p89-120
1974; 11refs
Supported by a grant from the Res. Applied to Nation's Needs Prog. of the National Science Foundation, with the cooperation of the International Harvester Corp. and the Trailmobile Div. of the Pullman Corp. Presented at a conference/workshop held at California Inst. of Tech., Pasadena, 10-11 Oct 1974.
Availability: In HS-017 615

HS-017 624

TRUCK DRAG REDUCTION PROGRAM AT UNIVERSITY OF OKLAHOMA

The investigation of aerodynamic drag reduction is described for full-scale pickup trucks (trucks equipped with an airfoil device travelling at speeds above 40 mph), tractor-trailer trucks (with and without air vanes at speeds up to 60 mph), and van trucks (with windows up and down on gravel and asphalt roads, with underinflated and properly-inflated tires, with and without fender skirts, and at speeds of 30, 45, and 60 mph). Thusfar, the most promising results (10% fuel consumption reduction at 55 mph) have been obtained with a pickup truck with the large airfoil on its roof. Photographs of the test vehicles are provided.

by Edward F. Blick; James B. Freim
University of Oklahoma, School of Aerospace, Mechanical and Nuclear Engineering, Norman, Okla. 73069
Publ: HS-017 615, Reduction of the Aerodynamic Drag of Trucks, Pasadena, Calif., 1974 p121-6
1974; 1ref
Presented at a conference/workshop held at California Inst. of Tech., Pasadena, 10-11 Oct 1974.
Availability: In HS-017 615

The development of an air deployable fairing for truck air-drag reduction, operating in the gap between a tractor and a trailer, stowed at low speeds (turns) and deployed at high speeds, is described from wind tunnel testing to full scale prototype tests. The problems encountered in the development program are discussed. The design, evolved through three prototype configurations (photographs provided) and more than 500,000 road test miles, has been shown to be a reliable, well performing system. Road testing indicates that fuel savings in the range of six to seven percent are readily achievable and with proper driver speed control considerably higher savings are possible. Tunnel testing shows drag reductions in the range of 20 to 30%. It is estimated that the fairing system is economically viable and could pay for itself in fuel savings in six to nine months.

by J. W. Tatom
Georgia Inst. of Tech., Engineering Experiment Station, Atlanta, Ga. 30332
Publ: HS-017 615, Reduction of the Aerodynamic Drag of Trucks, Pasadena, Calif., 1974 p127-38
1974; 4refs
Presented at a conference/workshop held at California Inst. of Tech., Pasadena, 10-11 Oct 1974.
Availability: In HS-017 615

HS-017 626

REDUCTION OF AERODYNAMIC DRAG OF LARGE HIGHWAY TRUCKS

A program involving field and road testing of single chassis truck units and tractor-trailer combinations was conducted to develop simple, legal, practical devices which would reduce aerodynamic drag. Deceleration, hill rolling, fuel flow, and fuel consumption tests were included. The devices, the conduct of the testing, and the performance of the devices are discussed. A simple, front lip-type device was developed which gave 23% fuel savings at 57 mph, on unloaded single chassis units. It is concluded that: substantial fuel savings of the order of 20% can be achieved by a full fairing device, and savings of 10% are attainable with simple devices such as the lip type; wind effects are very important and good quantitative crosswind data is not only essential but difficult to obtain; and the major elements contributing to truck drag are sharp corners on forward or longitudinal edges and gaps between tractor and trailer. An integral method for determining drag parameters from deceleration data is provided.

by Peter B. S. Lissaman; Jack H. Lambie
AeroVironment Inc., Pasadena, Calif.
Publ: HS-017 615, Reduction of the Aerodynamic Drag of Trucks, Pasadena, Calif., 1974 p139-51
1974; 1ref
Supported by the Res. Applied to National Needs Prog. of the National Science Foundation. Presented at a conference/workshop held at California Inst. of Tech., Pasadena, 10-11 Oct 1974.
Availability: In HS-017 615

HS-017 627

FIELD EXPERIENCE REPORT ON DRAG REDUCTION OF THE NOSE CONE

Field experience on the aerodynamic drag reduction of a device called the Nose Cone is reported. The device was tested on the following categories of tractor-trailer truck: owner operator (medium haul and coast-to-coast); supermarket fleet; moving vans (household van and electronic van); and private fleet. Test points included: fuel utilization, highway safety, trip time, driver reaction, maintenance, trailer characteristics, effect on cube, and effect on tractor. It was found that the amount of fuel saved with the Nose Cone device varied by fleet and by driver. Long haul drivers noticed an improvement in fuel consumption quicker because the same tractor and trailer were combined for a considerable period of time. Observations by fleet owners and drivers included: trailer sway was greatly reduced with the Nose Cone for those drivers with air ride suspension; head-wind lost time was reduced by as much as 50%; reduction in down-shifting reduced driver fatigue; trailers were damaged less by tree limbs (limbs tended to slide off); engines ran cooler and used less oil; and the device provided a unique three dimensional advertising space. It is concluded that a truly complete test of the Nose Cone can only be achieved if the same tractor-trailer combination can be kept together over several thousand miles.

by Joseph M. FitzGerald
FitzGerald Assoc., La Habra, Calif.
Publ: HS-017 615, Reduction of the Aerodynamic Drag of Trucks, Pasadena, Calif., 1974 p153-9
1974

Presented at a conference/workshop held at California Inst. of Tech., Pasadena, 10-11 Oct 1974.
Availability: In HS-017 615

HS-017 628

DRAG AND FUEL SAVING EVALUATION TECHNIQUES SUMMARY OF DISCUSSIONS IN THE WORKSHOP

Rough guidelines formulated for the acquisition of road vehicle test data from wind tunnels and road tests are discussed. Recommendations are made for wind tunnel testing, controlled or scientific road testing, and in-service testing. These include: wind tunnel data is the most desirable; a fixed plate ground plane installed well above the tunnel floor boundary layer should be used in wind tunnel testing; controlled road tests should be carried out under zero wind conditions and in dry weather; controlled fuel consumption tests are the most direct method for evaluating performance improvement devices; and in-service testing, because of the lack of control, should be seen as the least conclusive method of evaluation.

by William Bettes
California Inst. of Tech.
Publ: HS-017 615, Reduction of the Aerodynamic Drag of Trucks, Pasadena, Calif., 1974 p165-73
1974 ; 3refs

Presented at a conference/workshop held at California Inst. of Tech., Pasadena, 10-11 Oct 1974.
Availability: In HS-017 615

HS-017 629

TECHNIQUES FOR ROAD TESTING UNDER CONTROLLED CONDITIONS

Techniques for controlled hill rolling and fuel consumption tests on trucks are described. The test procedures and findings of a series of fifteen 90-mile runs using a 1967 turbocharged 3-axle cab-over-engine (COE) tractor with a 40-foot standard dry-van are detailed. The drag reducing capabilities of three retrofit devices were investigated (a nose cone device, a top edge lip device, and full fairs). The following conclusions can be drawn from these tests: with proper speed instrumentation, good grades, and calm conditions (less than 1/2 mph winds) hill rolling tests can determine changes in the drag coefficient to 1 or 2% accuracy; with appropriate precautions, a 100 mile fuel consumption test can give data accurate to about 2%; and the infrared tachometer is a very effective instrument for accurate unambiguous ground speed measurements under accelerating conditions.

by Jack H. Lambie
AeroVironment Inc., Pasadena, Calif.
Publ: HS-017 615, Reduction of the Aerodynamic Drag of Trucks, Pasadena, Calif., 1974 p183-8
1974

Presented at a conference/workshop held at California Inst. of Tech., Pasadena, 10-11 Oct 1974.
Availability: In HS-017 615

HS-017 630

AN EVALUATION OF TRUCK AERODYNAMIC DRAG REDUCTION DEVICES AND TESTS

A listing of aerodynamic drag reduction techniques, tests and computer simulators relating to fuel savings in the trucking industry is presented to provide an evaluation of the usefulness of the information to the industry and to formulate recommendations for activities which will accelerate the acceptance of these energy conservation approaches. Questionnaires were sent to and collected from 157 manufacturers, users, and testing agencies or facilities to obtain evaluation data. Data clearly demonstrate that significant fuel savings are achievable through the use of add-on aerodynamic drag reduction devices. An even greater potential for energy conservation is represented by work on new truck front-end designs, for which preliminary tests indicate savings of about 26% in fuel with a total systems approach. A continuing coordination phase of providing resource information for use by the industry is considered essential if the total activity is to amount to more than tokenism. Recommendations consider past and current efforts in the industry and in government. The program that is proposed calls for efforts expanding current research and suggests an overall course of action for accelerating acceptance of fuel reduction techniques by truckers. Appendices give mailing lists used and results of estimating the gross potential fuel savings possible by trucks in general and through the use of "drag fixes" in particular.

by Charles L. Brunow
Innocept, Inc., 4230 LBJ Freeway, Dallas, Tex. 75234
Rept. No. NSF-RA-N75-040 ; 1975 ; 174p 34refs
Based on a survey conducted for the Res. Applied to National Needs Prog. of the National Science Foundation.
Availability: RANN Document Center, National Science Foundation, Washington, D.C.

HS-017 631

POLICY ASSESSMENT OF THE 55 MILES PER HOUR SPEED LIMIT. FINAL REPORT

The effectiveness of the 55 mph national speed limit in conserving fuel is studied and the limit's impacts in the following areas are described: traffic safety; the economy (government revenues and costs, transportation, business/industry, and households); society in general (public response to the speed limit, impact on the individual, industry, and on institutions and values); and the law (legislative aspects and enforcement). The international aspects of the 55 mph speed limit (the energy crisis in Europe, speed reduction impacts, and post-fuel crisis information) are also discussed. It is concluded that: the 55 mph speed limit was not a major factor in gasoline consumption; short term fuel savings were achieved during the period immediately following the enactment of the 55 mph limit, but it is likely that most of this saving was due to the limited supply of gasoline; the 55 mph limit appears to be a contributing factor to lower fatality rates; the costs and dislocations to the trucking/bus industries resulting from the 55 mph limit have not been as great as initially projected; driver compliance and police enforcement of the limit eroded significantly after the lifting of the oil embargo; and the absence of significant educational and reinforcement mechanisms relative to the need for continuing energy conservation contributed to the erosion in driver compliance. Additional information is appended: a breakdown of typical petroleum products; a discussion of the Organization of Petroleum Exporting Countries; transcripts of the laws relating directly to the 55 mph speed limit; a chronology of the speed limit decision; and a breakdown of the results of a public opinion poll on the new reduced speed limits.

Mitre Corp., Westgate Res. Park, McLean, Va. 22101; BDM Corp., 1920 Aline Ave., Vienna, Va. 22180
Contract NSF-C925
1975; 176p
Availability: National Science Foundation, Washington, D.C.

HS-017 632

WET NIGHT VISIBILITY STUDY [ROADWAY MARKINGS]. FINAL REPORT

Apparatus and methods developed for characterization of roadway delineation systems are described, and laboratory and field tests are reported for a selection of 11 retroreflective systems. Hot sprayed and hot extruded thermoplastic striping applied in the standard marking pattern and in other patterns, asphalt bonded granite aggregate overcoated with white beaded paint, asphalt bonded Sinopal aggregate, button reflectors, and standard white beaded traffic paint were included in a full factorial field study covering about 15 miles of Interstate highway. Both visual effectiveness and maintenance studies were performed, and the effects of snowplow damage were assessed on a section of mountainous primary highway. Independent photometric methods yielded good correlation in laboratory and field, wet and dry (rainfall simulated) conditions, and the results were in agreement with visual evaluation. The button delineators were by far the most visible marking system under all night-time driving conditions; however, they required more frequent maintenance than painted or thermoplastic striping, and were the most expensive to apply. An economic analysis of the delineation systems based on performance, maintenance considerations, and application cost is presented and methodology for selecting one or a combination of several of the systems for a specific highway application is suggested.

by W. R. Tooke, Jr.; D. R. Hurst; R. G. Shackelford, ed.
Georgia Inst. of Tech., Engineering Experiment Station
1975; 240p 6refs
Performed under contract with the Georgia Dept. of Transportation (GDOT) in cooperation with the Federal Hwy. Administration. Rept. on GDOT Res. Proj. no. 6701. See also HS-015 858.
Availability: Georgia Dept. of Transportation; Federal Hwy. Administration

HS-017 633

RURAL TRAFFIC CRASHES. A STUDY OF ROAD ACCIDENTS WITHIN 100 MILES OF BRISBANE [AUSTRALIA] IN DECEMBER 1969 AND JANUARY 1970

A study was made of the circumstances, mechanisms, and effects of 81 consecutive severe traffic accidents on country roads within 100 miles of Brisbane, Australia. Accidents studied were those that occurred outside the boundaries of major cities in the area and resulted in injuries requiring medical attention. The method of the study was interviews of local police to whom an accident had been reported, examination of the scene of the accident, inspection of vehicles in most cases, interviews of drivers when possible, recording of resultant injuries from hospital and medical records, and surveys of documented information regarding the driving and criminal records of the drivers involved. Comparison with a previous series of metropolitan accidents indicated a higher proportion of single vehicle accidents together with greater damage to the vehicle and more severe injury to participants due to higher speeds. Sociological data (age, sex, background, and domicile) suggested that those involved differed statistically from drivers in general in various ways, including a higher incidence of criminal records in the accident series. This research stands as a basis for the design of objectives and methods for more intensive future studies.

by K. G. Jamieson; J. Allen; B. Moore; J. Scott; C. Wilson
Royal Brisbane Hosp., Dept. of Neurosurgery, Australia
1974; 85p 6refs
Availability: Corporate author

HS-017 634

TIRE REINFORCEMENTS, THEIR IMPACT ON COST AND SERVICE

The engineering functions of a tire and its dependence on the reinforcing material used are described. Prerequisites for an ideal tire carcass and ideal belt are suggested. Performance and material costs comparisons are made between the various types of tires (bias angle, bias belted, and radial ply construction) and materials (2 ply polyester, glass, Kevlar, and steel). The application of newer, high modulus materials to the construction of truck and bus tires and off-the-road and earthmover tires is also discussed.

by Richard J. Harrison
Uniroyal Tire Co., Textiles and Adhesives Res. and Devel.
1974; 13p
Presented at the National Symposium on Fiber Frontiers, Washington, D.C., 10-12 Jun 1974.
Availability: Uniroyal Tire Co., 6600 East Jefferson Ave., Detroit, Mich. 48232

HS-017 635

HS-017 635

THE ALCOHOL FACTOR IN ACCIDENTS

The effects of a limitation of the sale of alcohol on accidents were analyzed. The sale of alcohol in Finland is a state monopoly and in 1972 there was a six-week strike in which all alcohol shops were closed. Total alcohol consumption was reduced by one-third during the strike. A total of 1775 accident victims in the period of April 24 through June 2, 1972, in Helsinki, Finland were studied. Accident victims (1361 and 1754 respectively) for the same periods in 1970 and 1971 were used as controls. Information on every fourth patient and for each period was extracted and analyzed by computer. The following accident factors were included in the analysis: distribution among the days of the week; state of intoxication; type of accident; and place of accident. It was found that: there was no difference in the age distribution of accidents during the investigation and control periods; alcohol was a significant cause of accidents, especially on weekends; alcohol was of considerable significance as a causal factor in injuries due to violence; there was a statistically significant decrease in industrial and building-site accidents during the investigative period (a slight decrease on Mondays and greatest decrease on Fridays and pre-holiday weekdays); and alcohol seemed to have a greater causal role in accidents than had been shown previously from alcohol tests performed on accident victims.

by E. O. Karaharju; L. Stjernvall
Publ: Injury v6 n1 p67-9 (Aug 1974)
1974 ; 5refs

Availability: E. O. Karaharju, Dept. of Orthopaedics and Traumatology, University Central Hosp., Helsinki, Finland;
See publication

HS-017 636

THE USE OF SEAT BELTS BY MOTOR CAR OCCUPANTS INVOLVED IN ROAD TRAFFIC ACCIDENTS

A total of 244 automobile occupants involved in traffic accidents in Oxford, England (September-December 1971) who sustained injuries sufficiently severe to require admission to a hospital were investigated to assess the value of seat belts. Details of the accidents were gathered from questioning the patient at the hospital, the investigating police, the ambulance crew, or someone who was in the same vehicle. Accident injuries are broken down by type and extent for seat belt and non-seat belt wearers. Results indicate that the majority of drivers and front seat passengers of automobiles involved in accidents and who sustain injuries sufficiently severe to require hospital admission do not wear seat belts.

by C. S. B. Galasko; D. H. Edwards
Publ: Injury v6 n4 p320-4 (May 1975)
1975 ; 11refs

Availability: C. S. B. Galasko, Royal Postgraduate Medical School, Ducane Rd., London W12 0HS, England

HS-017 637

HIGHWAY VEHICLE SIMULATION

Various aspects of highway vehicle simulation are discussed. Guidelines are given for the simulation (by linear or nonlinear calculation) of handling response. Four passenger car and four commercial vehicle nonlinear simulations are discussed and

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reviewed in the following areas: the tire model, dictating the range of validity of the solution to directional response analysis and the usefulness of the simulation for combined braking and turning maneuvers; special features such as algorithms allowing impact with outside objects; and documentation. Some discussion of the computer simulation of ride is also presented.

by James E. Bernard
Highway Safety Res. Inst.
Publ: Shock and Vibration Monograph n10 p83-92 (1975)
1975 ; 27refs
Availability: See publication

HS-017 638

SIMULATION OF HUMAN BODY RESPONSE TO CRASH LOADS

Ten computer models of human body response to automobile crash loads are compared: sources of documentation, computer information, and contacts for obtaining the programs are given; the parameters defining the automobile occupants are compared; the means by which the forces are transmitted to the occupant are given; the acceleration or other kinematic inputs forcing a dynamic interaction between the environment and the occupant are given; and a summary of computer program information is provided. Each facet of the model comparisons and their results are briefly discussed. A schematic diagram showing the occupant linkage, vehicle contacts, and belt restraint system for one computer model is also provided.

by D. H. Robbins
Highway Safety Res. Inst.
Publ: Shock and Vibration Monograph n10 p365-80 (1975)
1975 ; 28refs
Availability: See publication

HS-017 639

THE 10 YEAR CAR?

The various economic factors which determine the desirable service life of a vehicle and its components are discussed: the challenge to industry to build more durable, longer-lasting, corrosion-resistant automobiles; the need to consider body repair after minor or major collisions as part of the overall service life concept; the short life philosophy; the conflict between short term and long term savings; ideas for a 20-year car; maintaining standards in a highly competitive market; and the long-life exhaust system. Current progress in longer-life vehicle production and the governmental role in the matter are considered. It is concluded that, although mechanical components of modern cars are more durable and the modern car body is being better protected against inside out corrosion than it was 10 years ago, there is a great need for improvement in specific areas to bring the service life of components to a level where most assemblies last the full service life of the car, which should not be less than 10 years.

by M. A. Jacobson
Publ: Engineering (London) v215 n8 p638-41 (Aug 1975)
1975
Availability: See publication

HS-017 640

TRAFFIC SPEED REPORT NO. 93. INTERIM REPORT

The rural traffic speeds on Indiana highways for the April-June 1975 period are reported. Observations of spot speeds were taken at two Interstate, two four-lane, and two two-lane highway locations by radar speed meters placed four feet from the pavement. Analysis of the speeds showed that the overall average speed for passenger cars was 57.6 mph and for heavy trucks, 55.5 mph. This was about the same overall average speed for passenger cars and for trucks, as was found in the data collected in June-September 1974. No trend of increase in travel speeds is yet apparent under the 55 mph maximum speed limit.

by A. A. Gadallah; G. K. Stafford; C. B. Reiling
Purdue Univ., Joint Hwy. Res. Proj., West Lafayette, Ind.
Rept. No. JHRP-75-16; 1975; 24p
Prepared in cooperation with the Indiana State Hwy.
Commission. See also HS-014 842 and HS-016 856.
Availability: Corporate author

HS-017 641

WARRANTS FOR LOCATION AND DESIGN OF LOCAL SERVICE ROADS

A research project was conducted to identify differences in operation and safety of highways with service road access control as opposed to direct access, to determine which traffic and geometric factors affect the operation and safety of the service road and highway at their points of intersection, and to apply these factors as criteria for the layout of various service road configurations. Data were collected at 11 service road locations, as well as two direct access locations, found in seven Indiana cities. A total of 51 service road and highway intersections, classified into various types, were studied at these locations. Conflicts data, volume data, accident and speed data, and questionnaire data (a business and a residential survey) were required for analysis. Accident data was utilized to detect patterns of hazardous movements at both service road and highway intersections. A comparison of speed characteristics for five pairs of locations revealed little difference in speeds on service road highways versus direct access highways. Questionnaire responses indicated that establishments on service roads fare just as well, if not better, than those with direct access. Regression analysis, for seven of the intersection types, was used to determine variables which best explained the conflicts index. For instance, the volume of traffic on the service road gave a reliable explanation of conflicts at three-legged service road connections to the highway. Evaluation of the range of operational experience at such intersections indicated a maximum service road volume of about 2000 vehicles per day for acceptable operation. Other recommendations derived from the analysis are also presented.

by Carl B. Baughman
Purdue Univ., Joint Hwy. Res. Proj., West Lafayette, Ind.
Rept. No. JHRP-75-18; 1975; 193p 63refs
Prepared in cooperation with the Indiana State Hwy.
Commission.
Availability: Corporate author

HS-017 642

GIANT NEW TESTING MACHINES REVEAL SURPRISING FACTS ABOUT TIRE PERFORMANCE

New tire performance findings, resulting from the use of newly developed testing machines, particularly the giant machines developed by Calspan and the Highway Safety Research Institute (HSRI), are discussed and analyzed. The effects of the following aspects of tire design and condition on performance are considered: material (steel versus fabric belts); tire diameter; inflation pressure; effect of tread wear on handling; and shoulder wear. The need for more data, the competitive views of the different test rigs, and the basic correlation between their data thus far are also discussed. Photographs of the HSRI and the Calspan tire testers and a schematic of the test planes and rotational axes for the tires tested are provided.

by E. F. Linsley
Publ: Popular Science v207 n5 p74-6, 140 (Nov 1975)
1975
Availability: See publication

HS-017 643

U. S. DEPARTMENT OF TRANSPORTATION 8TH ANNUAL REPORT. FISCAL YEAR 1974

Progress reports on the activities of various DOT-sponsored organizations are provided: the Office of the Secretary (economic regulation, promotion of and security in transportation, energy conservation, environmental protection, bicycling, and administration); United States (U.S.) Coast Guard (search and rescue, boating safety, enforcement, polar icebreaking, international ice patrol, deepwater ports, environmental protection, radio navigation programs, commercial vessel safety, vessel construction program, obstructive bridges program, and Coast Guard Reserve); Federal Aviation Administration (aviation safety and security, air traffic and the Airspace System, domestic aviation progress, aircraft noise reduction, international aviation activities, and emergency readiness); Federal Highway Administration (energy conservation, highway construction and improvement, and safety); Federal Railroad Administration (regional rail reorganization, railroad safety, the Alaska Railroad, research, development, and demonstration, advanced systems, and improving railroad productivity); National Highway Traffic Safety Administration (traffic safety, fuel shortage, alcohol abuse, crash survivability and avoidance, experimental safety vehicles, accident investigations, safety standards, and emergency medical services); Urban Mass Transportation Administration (capital assistance grants, transit planning, research and development, transit management, reorganization, and program review); and the St. Lawrence Seaway Development Corporation. Major statements and events, and spending and operational statistics relating to these organizations are appended.

Department of Transportation, Washington, D.C. 20590
Rept. No. AR-8; 1975; 64p
Availability: GPO

HS-017 644

GUIDELINES FOR ENHANCEMENT OF VISUAL CONSPICUITY OF TRAINS AT GRADE CROSSINGS. FINAL REPORT

Potential means of reducing the possibility of train-motor vehicle collisions at railroad-highway grade crossings through enhancement of the visual conspicuity of locomotives are examined. Passive visual alerting system techniques are reviewed, and requirements and constraints upon active systems are described. Past research is reviewed, followed by derivation of functional specifications and discussion of practical operating considerations. Operational tests of devices deemed most appropriate (xenon flash tube beacons) are described, with detailed recommendations. Four xenon beacons have been subjected to long term testing (two for 7000 hours and two for 5000 hours) on four different locomotives and their high durability has been demonstrated. Most train crew responses to the xenon beacons have been favorable but some apprehension was expressed regarding the effects of the intense light on crews working near the locomotive at night. Multiple intensity beacons (800 to 4000 candela for day and 100 to 400 candela for night use) are recommended for alerting. A series of amber-colored outline lights on the front corners of the locomotive and along the upper edges and side frames at 12 and 20 foot intervals, for a distance of at least 40 feet, are recommended for informing the motorist of the possible hazard. The total system (xenon beacon and outline lights) is estimated to cost about \$500 at installation. Estimates of system effectiveness yield a potential benefit-cost ratio of greater than 10.

by John B. Hopkins; A. T. Newfell
Transportation Systems Center, Kendall Square, Cambridge, Mass. 02142
Rept. No. DOT-TSC-FRA-74-15; FRA-OR&D-75-71; 1975; 55p
55p Refs
Rept. for Jun 1972-Nov 1974.
Availability: NTIS

HS-017 645

FEDERAL LEGISLATION AFFECTING MOTOR VEHICLE DESIGN. INTERIM REPORT

Federal legislation and regulations affecting, or having the potential to affect, the design and manufacture of motor vehicles are discussed. The statutory framework which provides the authority for Federal regulation in this field is considered: the National Traffic and Motor Vehicle Safety Act of 1966; the Interstate Commerce Act; Federal Aid Highway Weight and Width Provisions; the Highway Safety Act of 1966; the Motor Vehicle Information and Cost Savings Act; the Clean Air Act; and the Noise Control Act. The specific design and performance standards are outlined. These include specifications for: lighting devices and electrical equipment; brakes; glazing materials and window construction; fuel systems; exhaust systems; exhaust and fuel systems; interior features and crash protection; exterior strength and crash protection; tire and wheels; towing methods; and cargo loading.

by David Glater; Sarah Redfield
Transportation Systems Center, Kendall Square, Cambridge, Mass. 02142
Rept. No. DOT-TSC-OST-74-27; 1975; 65p
Rept. for Feb-Jun 1974.
Availability: NTIS

HS-017 646

TECHNOLOGICAL IMPROVEMENTS TO AUTOMOBILE FUEL CONSUMPTION. VOL. 1. EXECUTIVE SUMMARY. FINAL REPORT

by C. W. Coon
Southwest Res. Inst., Dept. of Automotive Res., San Antonio, Tex. 78284
Contract DOT-TSC-628
Rept. No. DOT-TSC-OST-74-39.1; 1974; 13p
Rept. for Jun 1973-Jan 1974. For abstract, see vol. 2A (HS-017 647) and vol. 2B (HS-017 648). Partly sponsored by the Environmental Protection Agency.
Availability: NTIS

HS-017 647

TECHNOLOGICAL IMPROVEMENTS TO AUTOMOBILE FUEL CONSUMPTION. VOL. 2A. SEC. 1 THROUGH 23. FINAL REPORT

A series of viable technological improvements which should result in a 30% or more reduction in fuel consumption relative to 1973 vehicles is defined. The interrelationships between various automobile design characteristics, as they influence operating fuel economy and increase the relationship between the vehicle power plant emissions and fuel economy potential, are emphasized. Reference vehicles, equipped with standard V-8 engines, power steering, automatic transmissions, and optional air conditioning were selected for study due to their high sales volume in 1972: Ford Galaxie, Ford Mustang, Chevrolet Impala, Chevrolet Camaro, Plymouth Fury, and Dodge Challenger. These vehicles (weighing from 3500 to 4500 pounds with a full tank of gas) were used in the study for two main reasons: to acquaint the researchers with some of the details of 1973 technology; and to provide test data for in-house use by the Department of Transportation. The following vehicle design improvement factors are studied: the fuel economy of carbureted spark-ignition engines; the exhaust emissions of automotive spark-ignition carbureted engines; variable displacement engines; engines with reduced friction; lean mixture engines; intake port fuel injection; stratified charge engines; diesel engines; drive train improvements; tire, aerodynamic, and weight improvements; accessory drives; air-conditioning and cooling system improvements; and the turbo-charged, spark-ignited, carbureted engine.

by C. W. Coon
Southwest Res. Inst., Dept. of Automotive Res., San Antonio, Tex. 78284
Contract DOT-TSC-628
Rept. No. DOT-TSC-OST-74-39.2A; 1974; 217p
Rept. for Jun 1973-Jan 1974. Partly sponsored by the Environmental Protection Agency. See also vol. 1, Executive Summary (HS-017 646), and vol. 2B (HS-017 648).
Availability: NTIS

HS-017 648

TECHNOLOGICAL IMPROVEMENTS TO AUTOMOBILE FUEL CONSUMPTION. VOL. 2B. SEC. 24 AND 25, AND APPENDIXES A THROUGH I. FINAL REPORT

The feasibility of technological improvements for reducing automobile fuel consumption is studied. The value of certain individual improvements is summarized. Some design com-

number stratified charge; and turbocharged diesel engines; weight reduction from 4300 pounds to 3800 pounds with or without size reduction; radial ply tires; three speed automatic and axle change transmissions; reduced frontal area for reduced aerodynamic drag; and clutch fans. Detailed specifications for the Ford, Chevrolet, and General Motors automobiles used as reference vehicles and complete results from the power tests, road tests, dynamometer tests, and fuel economy calculations to which they were subjected are appended.

by C. W. Coon
Southwest Res. Inst., Dept. of Automotive Res., San Antonio,
Tex. 78284
Contract DOT-TSC-628
Rept. No. DOT-TSC-OST-74-39.2B; 1974; 178p 208refs
Rept. for Jun 1973-Jan 1974. Partly sponsored by the
Environmental Protection Agency. See also, vol. 1, Executive
Summary (HS-017 646), vol. 2A and (HS-017 647).
Availability: NTIS

HS-017 649

A STUDY OF TECHNOLOGICAL IMPROVEMENTS IN AUTOMOBILE FUEL CONSUMPTION. VOL. 1. EXECUTIVE SUMMARY. FINAL REPORT

by Donald A. Hurter
Arthur D. Little, Inc., Acorn Park, Cambridge, Mass. 02140
Contract DOT-TSC-627
Rept. No. DOT-TSC-OST-74-40.1; 1974; 52p
Rept. for Jun 1973-Jan 1974. Partly sponsored by the
Environmental Protection Agency. For abstracts, see vol. 2
(HS-017 650), vol. 3A (HS-017 651), and vol. 3B (HS-017 652).
Availability: NTIS

HS-017 650

A STUDY OF TECHNOLOGICAL IMPROVEMENTS IN AUTOMOBILE FUEL CONSUMPTION. VOL. 2. COMPREHENSIVE DISCUSSION. FINAL REPORT

Research was conducted to provide some insight into the factors affecting passenger automobile fuel consumption and to identify and evaluate available technological improvements which can reduce the fuel consumption (gallons per mile) of the 1973 passenger automobile by 30%, or improve its fuel economy, measured in miles per gallon (mpg), by 43%. Reference vehicles, 1973 standard size (3,800 to 4,200 pounds) and compact size (2,750 to 3,200 pounds) cars, were selected because they were considered representative of buyer preference in engine size and type, body style, and optional equipment: Ford Maverick 4 door sedan and L.T.D. 2 door hardtop; General Motors Nova 4 door sedan and Impala 2 door hardtop; Chrysler Valiant 4 door sedan and Fury 2 door hardtop; and an American Motors Hornet 4 door sedan, and Ambassador. A simple model was developed for measuring fuel consumption, considering the effects of different driving loads, cycles, and conditions. Data on automobile power use was obtained from automobile manufacturers, component manufacturers, support industries, and independent experts. Fuel economy and performance levels for both the compact and standard cars were computer modelled and simulated, improvements were assessed, and synthesized design vehicles were developed and ranked. It is concluded that: the goal of a 43% improvement in fuel economy or 30% reduction in fuel

structure which reduce weight, air drag, and rolling resistance; in transmissions to match engine coupling to road load, and in engines with the diesel or stratified charge-type engines; and the development of a body and chassis with 10% less weight, 10% less frontal area, 20% less air drag, and radial instead of bias-belted tires would give a 9-13% mpg gain. Also, the matching of power plant to drive train can be improved by the use of an automatic four-speed transmission with torque converter lock-up or a continuously variable transmission.

by Donald A. Hurter
Arthur D. Little, Inc., Acorn Park, Cambridge, Mass. 02140
Contract DOT-TSC-627
Rept. No. DOT-TSC-OST-74-40.2; 1974; 235p
Rept. for Jun 1973-Jan 1974. Partly sponsored by the
Environmental Protection Agency. See also vol. 1, Executive
Summary (HS-017 649), vol. 3A (HS-017 651), and vol. 3B (HS-017 652).
Availability: NTIS

HS-017 651

A STUDY OF TECHNOLOGICAL IMPROVEMENTS IN AUTOMOBILE FUEL CONSUMPTION. VOL. 3A. APPENDIXES 1 THROUGH 3. FINAL REPORT

General appendices are presented to a study conducted to determine potential improvements in automobile fuel consumption based on innovative design and components. A summary of sources (automobile and component manufacturers, support industries, and independent experts) and types of data collected and a sample of the questionnaire sent to the sources are provided. Characteristics of the composite car (synthesized design vehicle) for both compact and standard size are given along with the responses from industry to the study findings. Performance data on the various design innovations in vehicle powerplants, transmissions, and oil additive suggestions are detailed.

by Donald A. Hurter
Arthur D. Little, Inc., Acorn Park, Cambridge, Mass. 02140
Contract DOT-TSC-627
Rept. No. DOT-TSC-OST-74-40. 3A; 1974; 199p
Rept. for Jun 1973-Jan 1974. Partly sponsored by the
Environmental Protection Agency. See also vol. 1, Executive
Summary (HS-017 649), vol. 2 (HS-017 650), and vol. 3B (HS-017 652).
Availability: NTIS

HS-017 652

A STUDY OF TECHNOLOGICAL IMPROVEMENTS IN AUTOMOBILE FUEL CONSUMPTION. VOL. 3B. APPENDIXES 4 THROUGH 7. FINAL REPORT

Several appendices to a study conducted to identify and evaluate various technological improvements capable of reducing automobile fuel consumption are presented. Various fuel economy and exhaust emission test procedures and standards are detailed and final report of the overall study program is given. Computer simulation runs for the reference vehicles developed in the study are summarized and computer run sheets are provided.

by Donald A. Hurter
Arthur D. Little, Inc., Acorn Park, Cambridge, Mass. 02140
Contract DOT-TSC-627
Rept. No. DOT-TSC-OST-74-40. 3B ; 1974 ; 227p 460refs
Rept. for Jun 1973-Jan 1974. Partly sponsored by the
Environmental Protection Agency. See also vol. 1, Executive
Summary (HS-017 649), vol. 2 (HS-017 650), and vol.3A (HS-
017 651).
Availability: NTIS

HS-017 653

A REVIEW OF PROPOSED AUTOMOTIVE CARBURETOR CONCEPTS FOR IMPROVED FUEL ECONOMY. INTERIM REPORT

Fuel economy improvement through carburetion improvements is discussed. The conventional carburetor is described in some detail: carburetor requirements (idling and low load, medium loads or cruise, high loads, and transient mixture requirements); carburetor construction and operation (main metering system, idling system, accelerating system, and operational characteristics); and inherent limitations (atomization and vaporization, maldistribution effects, air-fuel ratio effects and limits, and overall effects). Current carburetor improvements being developed by the auto industry for near-term implementation are delineated. A number of selected, specific carburetors currently being produced or discussed are examined as to their status: electrosonic fuel induction system; ultrasonic fuel system; Cal-Tech super carburetor; air valve carburetors; Woodworth carburetor; Kendig carburetor; Arpaia fuel injection carburetor; Dresserator system; Fish carburetor; Gelb digital controlled carburetor; Pogue carburetor; Fessenden carburetor system; Vaporator; Vapipe; and Graybill "VMM" injector. The examination includes: principal claimed advantages; principles of operation and construction; available substantive data on fuel economy effects; disadvantages; current development status; and costs.

by M. G. Hinton; J. Meltzer; T. Iura; L. Forrest; W. Smalley; K. Swan
Aerospace Corp., Environmental and Urban Div., El Segundo, Calif. 90245
Contract F04701-74-C0075
Rept. No. DOT-TSC-OST-74-41 ; 1975 ; 95p 50refs
Rept. for May-Sep 1974.
Availability: NTIS

HS-017 654

AUTOMOTIVE ENERGY EFFICIENCY PROGRAM. CONFERENCE PAPERS OF THE CONTRACTORS COORDINATION MEETING, JANUARY 15-17, 1975, (HELD AT) TRANSPORTATION SYSTEMS CENTER, CAMBRIDGE, MASS.

The proceedings of a conference held to report on the progress and future plans of the Automotive Energy Efficiency Program and to promote the exchange of information between government; industry and university investigators are presented. Nineteen papers and illustrated lectures are included on the following topics: truck fuel economy state-of-the-art; highway vehicle retrofit; automotive power plants; lean mixture engine testing; lithium/sulfur batteries for automobiles; aerodynamic drag reduction for tractor-trailer combinations; automotive aerodynamic drag; rolling resistance of pneumatic tires; automotive fuel economy; automotive fuel

flow meters; automotive data base and impact; safety implications of small car usage; energy management in transportation systems; closed loop control of spark timing; and the development of the valved hot-gas engine. Other topics are: alcohols as vehicle fuel extenders; the performance and emissions of hydrogen fueled internal combustion engines; and hydrogen car development.

by Harold G. Miller
Transportation Systems Center, Kendall Square, Cambridge, Mass. 02142
Rept. No. DOT-TSC-OST-75-31 ; 1975 ; 271p
Includes HS-017 655--HS-017 672.
Availability: NTIS

HS-017 655

TRUCK FUEL ECONOMY STATE-OF-THE-ART ASSESSMENT

A study was conducted to determine the potential reduction in truck fuel consumption based on the use of innovative systems and improved components. Technological areas investigated were: spark ignited engines with and without turbocharging; electronic feedback controlled fuel injection with dual bed catalytic converters; stratified charge combustion; lightweight diesels; lock-up torque converters; continuously variable ratio transmission; tires aerodynamic drag; vehicle weight; engine accessories; and optional equipment. Seven 1973 model year trucks from various weight and duty classes were selected for analysis using a computer simulation program to predict fuel usage and performance with and without incorporation of the improvements: a Chevrolet C-10 pickup (mixture of local, short and long haul); a Ford F-250 camper pick-up (mixture of local, short, and long haul); International Harvester 1800 and 1850 vans (local haulings); a Mack DM-600 (local and short haul); and an International Harvester Transtar F-4379 (long haul). Estimates were made as to whether modified vehicles complied with study constraints such as emission, safety, noise and user requirements. Cost effectiveness, manufacturing adaptability and probable time frame for the introduction of improvements were also estimated. Though study is not yet complete, it is indicated that material improvement in fuel economy of 1973 trucks can be attained on a mass produced scale by the early 1980's.

by Donald A. Hurter
Arthur D. Little, Inc., Cambridge, Mass.
Publ. HS-017 654 (DOT-TSC-OST-75-31) Automotive Energy
Efficiency Prog., Cambridge, Mass., 1975 pl-18
Presented at the meeting held 15-17 Jan 1975, Cambridge, Mass.
Availability: In HS-017 654

HS-017 656

HIGHWAY VEHICLE RETROFIT EVALUATION

The current status of the Highway Vehicle Retrofit Evaluation program is presented. The program attempts to evaluate the potential of used car and truck fuel economy retrofit devices for reducing fuel consumption in a timely, economic, and effective manner, and to provide the information necessary for the Federal government to determine if it should encourage the use of such retrofit concepts. Over 20 representative classes of retrofit devices/concepts/techniques, including over 130 specific items, were examined. A major portion of the

analysis effort was directed to the evaluation of 16 new advanced carburetors having the potential to improve automotive fuel economy. Other devices examined included: acoustic and mechanical atomizers; lean-bleed devices; vapor injectors; fuel modifications (additives, blends of water, alcohol, and gasoline); inlet manifolds; ignition systems; drivetrain components (radial tires, transmissions, and overdrives); drag reduction techniques; driver aids; cooling fans; valve timing modifications; tune-ups; compression ratio increases; exhaust-related systems (tuned exhaust systems and turbochargers); and engine oils, oil additives, and filters.

by Joseph Meltzer

Aerospace Corp., El Segundo, Calif.

Publ: HS-017 654 (DOT-TSC-OST-75-31) Automotive Energy Efficiency Prog., Cambridge, Mass., 1975 p19-33
1975

Presented at the meeting held 15-17 Jan 1975, in Cambridge, Mass.

Availability: In HS-017 654

HS-017 657

AUTOMOTIVE POWER PLANT EVALUATION

A brief description is presented of a new research program designed to obtain automotive engine performance data for use in estimating vehicle emissions and fuel economy in varied service and duty. An experimental test procedure for generating fuel consumption and emissions data adequate to describe an engine's characteristics over its full operating range, including transient modes, is to be developed and validated. These data, "engine maps", are to be obtained for 23 different engines, including: 15 current production spark ignition engines, 4 pre-production or prototype advanced design spark ignition engines (lean-burn); and 4 diesel engines which are, or might be, used in passenger car applications. Engine mapping was initiated with a Honda CVCC engine. Data from steady-state modes, including motor operation, were included. Although there were variations in air-fuel ratio over the test period, emissions and fuel consumption were fairly stable.

by William F. Marshall

Bureau of Mines, Bartlesville Energy Res. Center, Okla.

Publ: HS-017 654 (DOT-TSC-OST-75-31) Automotive Energy Efficiency Prog., Cambridge, Mass., 1975 p35-8
1975

Presented at the meeting held 15-17 Jan 1975, in Cambridge, Mass.

Availability: In HS-017 654

HS-017 658

LEAN MIXTURE ENGINE TESTING AND EVALUATION

Research aimed at defining analytically and demonstrating experimentally the potential of the lean burn concept is presented. Fuel consumption and emissions data were obtained on an engine dynamometer for the baseline engine (a 1973 Chevrolet 350 cubic inch V8) and two lean burn configurations of the same engine. Data comparisons were made. Individual cylinder equivalence ratios were measured to evaluate the cylinder-to-cylinder distribution. Pressure-time traces from individual cylinders were used to get information about ignition delay, combustion duration and cycle-to-cycle pressure variations. Fuel consumption and emissions data for one lean burn configuration were obtained over the Federal Driving Cycle

using a chassis dynamometer. The results were compared with the stock baseline results. Using experimental results and information from the existing literature, the potential of the lean-burn concept was assessed using the Blumberg-Kummer cycle analysis program. The lean mixture engine, when tuned for maximum fuel economy with no emissions devices in operation, yielded a 12% decrease in brake specific fuel consumption when compared to the emissions controlled stock engine. Using engine dynamometer mapping data, a 22% improvement in miles per gallon (mpg) over the Federal Driving Cycle was estimated using the computer program; and even when the engine is tuned to meet the 2 grams per mile nitric oxide emissions standards it will show 12% better mpg than the stock vehicle.

by M. W. Dowdy

Jet Propulsion Lab., California Inst. of Tech., Pasadena, Calif.

Publ: HS-017 654 (DOT-TSC-OST-75-31) Automotive Energy Efficiency Prog., Cambridge, Mass., 1975 p39-50
1975

Presented at the meeting held 15-17 Jan 1975, at Cambridge, Mass.

Availability: In HS-017 654

HS-017 659

EVALUATION OF LITHIUM/SULFUR BATTERIES FOR AUTOMOBILES

A lithium-aluminum/metal sulfide (Li-Al/FeS) battery (60 kilowatts, 42 kilowatt-hours, 350 kilograms) was designed for installation under the hood of a compact car (3400 pounds) having a range of about 100 miles. Calculations showed that this battery could be recharged at home in about five hours and recharged at a recharging station in one to two hours. A Li-Al/FeS2 cell having a capacity of about 100 amp-hours and weighing 1.8 kilograms is being tested on a computer controlled cycling system that simulates the power requirements for automobile driving conditions. On the SAE-J227 driving profile and with a maximum power draw of 45 watts, the cell completed 275 driving cycles in a single discharge of 67.5 amp-hours. The performance projected for improvements in the cells now underway indicates that the calculated performance required for the automobile battery is obtainable with this Li-Al/FeS system.

by Paul A. Nelson

Argonne National Lab., Argonne, Ill.

Publ: HS-017 654 (DOT-TSC-OST-75-31) Automotive Energy Efficiency Prog., Cambridge, Mass., 1975 p51-74
1975 ; 4refs

Presented at the meeting held 15-17 Jan 1975, at Cambridge, Mass.

Availability: In HS-017 654

HS-017 660

AERODYNAMIC DRAG REDUCTION TESTS ON A FULL-SCALE TRACTOR-TRAILER COMBINATION WITH SEVERAL ADD-ON DEVICES

Aerodynamic drag tests were performed on a conventional cab-over-engine tractor with a 45-foot van-type trailer (total weight 30,000 pounds) with five potentially available add-on devices (three cab-mounted, and two trailer-mounted) using the coast-down method. The tests ranged in velocity from about 30 mph to 65 mph and included some flow visualization. Tests were run on an airport runway, most of the time in calm

wind conditions, and the gap between tractor and trailer was either 62 or 40 inches. Deceleration measurements were made with both accelerometers and stop watches. Ambient pressure, temperature, and wind velocity and direction were recorded. It was found that: moving the trailer forward from 62 to 40 inches reduced the aerodynamic drag for the baseline configuration about 10% at zero wind conditions; the maximum aerodynamic drag reduction realized from an add-on device at zero wind conditions was about 24% for the rear trailer position; some add-on devices provided only small drag reductions; and the ability of some devices to reduce drag appeared to be reduced by crosswinds.

by Lawrence C. Montoya; Louis L. Steers
NASA Flight Res. Center, Edwards, Calif. 93523
Publ: HS-017 654 (DOT-TSC-OST-75-31) Automotive Energy Efficiency Prog., Cambridge, Mass., 1975 p75-93
1975 ; 7refs
Presented at the meeting held 15-17 Jan 1975, at Cambridge, Mass.
Availability: In HS-017 654

HS-017 661

STUDY OF AUTOMOTIVE AERODYNAMIC DRAG

A sub-scale wind tunnel test using a 40% scale model of a 1974 Ford Mustang II notch-back coupe with two different modified noses, full and partial underpans, front skirts or dams, and rear trunk spoilers was run in a 10 foot wind tunnel. Full-scale wind tunnel tests were run with three vehicles: a Chevrolet Impala, a Plymouth Valiant, and a Ford Mustang II. Vehicle modifications included: a skirt at the front bumper with a 5.5 to 8.5 inch ground clearance; a rounded nose; a right angle corner at the trunk rear edge for the Impala and Valiant; and a 2-inch high spoiler for the Mustang II. Drag reductions in the range of 20-30% were found to be possible in these tests. Initial results from a preliminary road test (80 runs) using a cost-down technique with a 1975 Chevrolet Impala Sport Sedan have shown that this technique can be used to obtain accurate and realistic aerodynamic drag and rolling resistance information representative of an actual vehicle under real operating conditions. This is demonstrated by the small scatter in the inferred resistances and the small deviation in the base raw data. Photographs of the test models are provided.

by Jack E. Martie; Bain Dayman, Jr.
California Inst. of Tech., Jet Propulsion Lab., Pasadena, Calif.
Publ: HS-017 654 (DOT-TSC-OST-75-31) Automotive Energy Efficiency Prog., Cambridge, Mass. 1975 p95-106
1975
Presented at the meeting held 15-17 Jan 1975, in Cambridge, Mass.
Availability: In HS-017 654

HS-017 662

AUTOMOTIVE FUEL ECONOMY EVALUATION

A brief description is provided of the progress of a study initiated in 1973 and dedicated to experimental characterization of 1973 standard and intermediate size vehicles and to identification and evaluation of possible methods of improving fuel economy. Gravimetric, volumetric, and carbon balance fuel measurement techniques are being compared during chassis dynamometer operation. Road tests, stationary dynamometer tests, and chassis dynamometer tests are being conducted on

1974 subcompacts. In addition, tire rolling resistance is being determined using a mobile facility that minimizes the effects of air drag. A series of chassis dynamometer tests of the effect of warm-up on fuel economy and a comparison of intake port fuel injection and carburetion on otherwise comparable vehicles are to be conducted.

by Carlos W. Coon, Jr.
Southwest Res. Inst., San Antonio, Tex.
Publ: HS-017 654 (DOT-TSC-OST-75-31) Automotive Energy Efficiency Prog., Cambridge, Mass., 1975 p117-9
1975
Presented at the meeting held 15-17 Jan 1975, at Cambridge, Mass.
Availability: In HS-017 654

HS-017 663

EVALUATION OF AUTOMOTIVE FUEL FLOWMETERS

Fuel flowmeters measure the gasoline consumed by an engine either on the road or on a dynamometer. The following aspects of flowmeters are discussed: the different kinds of flowmeters; the automobile environment of a flowmeter (flowmeter temperature, fuel temperature, pressure, density, viscosity, color, opacity, flow pulsations, back flow, swirl due to elbows, line voltage fluctuations, electromagnetic radiation from ignition, vehicle attitude with respect to the vertical, and vibration); and plans for a test set-up for evaluating and calibrating these meters in the laboratory under conditions simulating the automotive environment.

by Baldwin Robertson
National Bureau of Standards, Washington, D. C.
Publ: HS-017 654 (DOT-TSC-OST-75-31) Automotive Energy Efficiency Prog., Cambridge, Mass., 1975 p121-34
1975 ; 5refs
Presented at the meeting held 15-17 Jan 1975, at Cambridge, Mass.
Availability: In HS-017 654

HS-017 664

AUTOMOTIVE DATA BASE AND IMPACT ASSESSMENT

The Automotive Data Base, a basic computer system used for simulations and analyses of investments, vehicle costs, and total costs to the customer for the implementation of various vehicles and engines, is briefly discussed. Included in the Automotive Data Base are: vehicles and components, facilities and machinery, vendors, maintenance, and fuel economy. The discrete data developed is used to evaluate the aggregate impacts of alternative governmental automotive policy decisions. Two impacts are assessed: that on the automotive manufacturers, expressed as total yearly investment to implement a policy and as the investment per car for the various types of cars likely to be produced under the policy; and that on the driving public expressed as aggregate yearly fuel costs, maintenance and sticker price.

March 31, 1976

by L. H. Lindgren; Merrill L. Ebner
Rath and Strong, Inc., Lexington, Mass.; Boston Univ.,
Boston, Mass.
Publ: HS-017 654 (DOT-TSC-OST-75-31) Automotive Energy
Efficiency Prog., Cambridge, Mass., 1975 p135-46
1975; 15refs
Presented at the meeting held 15-17 Jan 1975, at Cambridge,
Mass.
Availability: In HS-017 654

HS-017 665

SAFETY IMPLICATIONS OF SMALL CAR USAGE

The state-of-the-art knowledge on the relation between automobile size and motor vehicle accidents is summarized. A study was conducted into the influence of car size on: single car accidents, accidents involving more than two cars; car-truck accidents; pedestrian and bicycle accidents; interactions with speed; and fatalities. Estimates and projections for the following scenarios were made: four alternative compositions (for each car class) of car sales from 1972 through 1985; assuming optional and mandatory installation of air cushion restraint systems; reduction of travel by elimination of all Sunday travel, 10%, 20%, or a 30% reduction in commuter traffic; and the 55 mph speed limit enforced as currently done, enforced, and rescinded and enforced at previous levels. The limitation of the data bases and the results are discussed. Changes in car occupant deaths resulting from a shift in the car-size mix over the next 10 years are projected. The effects of the speed limit and changing vehicle use are discussed.

by H. C. Joksich
Center for the Environment and Man, Hartford, Conn.
Publ: HS-017 654 (DOT-TSC-OST-75-31) Automotive Energy
Efficiency Prog., Cambridge, Mass., 1975 p147-52
1975
Presented at the meeting held 15-17 Jan 1975, in Cambridge,
Mass.
Availability: In HS-017 654

HS-017 666

INCREASED FUEL ECONOMY IN TRANSPORTATION SYSTEMS BY USE OF ENERGY MANAGEMENT

A program of research is being conducted to investigate energy management techniques within the engine-transmission system of an automotive vehicle which has the potential of producing significantly better fuel mileage than is currently obtainable. The following possibilities of energy management are discussed: replacing the present-day automatic transmission with an optimized continuously-variable transmission; a modeling technique permitting instantaneous values of carbon monoxide, nitric oxides, and hydrocarbon emissions to be accurately predicted for any point of any realistic driving cycle; and the use of a powerplant system combining a prime mover with a high speed flywheel for energy storage. The latter technique has proven most effective in preliminary evaluation. With this concept, it is possible to use the prime mover only under near-ideal conditions, and efficient regenerative braking is possible.

HS-017 668

by N. H. Beachley; A. A. Frank
University of Wisconsin, Madison, Wisc.
Publ: HS-017 654 (DOT-TSC-OST-75-31) Automotive Energy
Efficiency Prog., Cambridge, Mass., 1975 p153-71
1975
Presented at the meeting held 15-17 Jan 1975, at Cambridge,
Mass.
Availability: In HS-017 654

HS-017 667

CLOSED-LOOP CONTROL OF SPARK TIMING

Investigations aimed at reducing the degradation of spark advance settings with time and providing automatic adjustments of spark timing to changing engine and environmental conditions are discussed. The status of the program of research is reviewed with particular emphasis on the measurements being made and the mechanization of control (fuel-air ratio control and spark advance control). It is concluded that: peak cylinder pressure position (PPSN) measurement and the adjustment of spark advance to maintain a constant PPSN seem to be valuable for closed loop spark advance control; the degradation in engine performance over the true optimum schedule is less than 0.1% using the PPSN control; insensitivity to fuel-air ratio and humidity has been demonstrated; and, while performance losses due to current open loop systems have been shown to be about 3% from humidity changes only, the combined losses which could be recovered with a closed loop controller appear to be on the order of 5%.

by J. David Powell; Mont Hubbard
Stanford Univ., Palo Alto, Calif.; Univ. of California, Davis,
Calif.
Publ: HS-017 654 (DOT-TSC-OST-75-31) Automotive Energy
Efficiency Prog., Cambridge, Mass., 1975 p173-85
1975; 2refs
Presented at the meeting held 15-17 Jan 1975, at Cambridge,
Mass.
Availability: In HS-017 654

HS-017 668

DEVELOPMENT OF THE VALVED HOT-GAS ENGINE

The development of the Massachusetts Institute of Technology (MIT) valved hot-gas engine (VHGE), a closed-regenerative-cycle engine using helium or hydrogen as the working fluid and a reciprocating compressor/expander, is described. The VHGE is compared to the Stirling engine (an engine of high power densities and high efficiency). The major difference is in the heat transfer components. The VHGE employs heat exchangers with steady unidirectional flow at constant pressure, whereas the Stirling engine uses heat exchangers with oscillating flow and pressure. The advantages of the VHGE include: greater design flexibility and direct cooling; and reduced heat load on the regenerator. The scope, progress, and future plans of the development program are discussed. Analytical and experimental work is underway to explain more fully the observed engine performance characteristics; variable valve timing for improved VHGE power control is also being investigated.

by Joseph L. Smith
Massachusetts Inst. of Tech., Cambridge, Mass.
Publ: HS-017 654 (DOT-TSC-OST-75-31) Automotive Energy
Efficiency Prog., Cambridge, Mass., 1975 p187-96
1975 ; 3refs
Presented at the meeting held 15-17 Jan 1975, at Cambridge,
Mass.
Availability: In HS-017 654

HS-017 669

ALCOHOLS AS VEHICLE FUEL EXTENDERS

The effects of adding alcohol to unleaded gasoline to increase the volume of liquid fuel for vehicle use are investigated. Areas examined include: the octane characteristics of alcohol-gasoline blends; engine parameter studies to determine if spark timing and other engine variables can be adjusted to maintain fuel economy and control emissions; the relationship between exhaust aldehydes and fuel alcohol content including the effect of a platinum oxidizing converter; and a simulation of the Federal Test Procedure for emission certification to determine the effect of fuel alcohol on emissions and fuel economy for this data form. Methanol was chosen as the most important alcohol to be used in the study because the technology exists to manufacture it from coal. A brief summary of the octane test program for methanol-gasoline blends (conducted on a single cylinder engine) is provided. It appears that for the fuels tested (a regular, regular unleaded, premium unleaded, and indolene unleaded gasoline) methanol produces no degradation of the octane ratings and, in fact, provides an increase in the octane ratings of the lower octane base fuels.

by R. T. Johnson
University of Missouri, Rolla, Mo.
Publ: HS-017 654 (DOT-TSC-OST-75-31) Automotive Energy
Efficiency Prog., Cambridge, Mass., 1975 p197-206
1975
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Mass.
Availability: In HS-017 654

HS-017 670

PERFORMANCE AND EMISSIONS OF HYDROGEN FUELED INTERNAL COMBUSTION ENGINES

A description is given of the difference between the hydrogen engines and engines running on hydrocarbon fuels. The differences arise from properties of hydrogen such as high flame speed, a very low lean flammability limit, low ignition energy and high ignition lag times for auto-ignition at high pressures. These properties, while providing the potential of high thermal efficiency at part load, can be the cause of pre-ignition and backfiring problems. The problems can be solved by the use of direct cylinder fuel injection, of lean mixtures, or of low compression ratios. Direct cylinder injection has the additional advantage of providing a high maximum power output. The thermal efficiency of hydrogen engines is discussed in detail. Also discussed are the phenomena leading to irregular engine operation such as surface ignition and spark knock. While spark knock occurs only at very high compression ratios, it may cause the engine to run rough. Even at moderately high compression ratios, combustion in hydrogen engines is accompanied by pressure waves. A detailed analysis is given to nitrogen oxide (NO) production. For lean mixtures, the NO emissions are limited by the rate of formation, and for rich mixtures by the rate of decomposition during the expansion

process. NO emissions are negligibly small for fuel-air equivalence ratios below about 0.55. Peak NO emissions occur at equivalence ratios near 0.8, and are of the same order as for gasoline engines. It is concluded that the hydrogen engine is a practical possibility, likely to find a number of applications within the next few decades.

by P. C. T. de Boer; W. J. McLean; H. S. Homan
Cornell Univ., Ithaca, N.Y. 14850
Contract Ref: DOT-OS-30113
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Efficiency Prog., Cambridge, Mass., 1975 p207-31
1975 ; 49refs
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Mass. Supported in part by Dept. of Transportation, Office of
Univ. Res.
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HS-017 671

PERFORMANCE AND EMISSION MODELING FOR H2 [HYDROGEN] FUELED I. C. [INTERNAL COMBUSTION] ENGINES

A numerical model of a complete internal combustion engine cycle has been constructed to carry out performance and emissions estimates for a hydrogen-fueled engine over a wide range of operating conditions and to elucidate those processes which differentiate hydrogen fueled engines from gasoline engines. A fuel-air Otto cycle analysis shows that in the same engine with a pre-mixed stoichiometric fuel-air charge, gasoline and hydrogen gives about the same thermal efficiency, but that gasoline gives 20% more power. If the hydrogen is injected directly into the cylinder, power is increased 40% so that a direct injection hydrogen engine gives about 20% more power than a carbureted gasoline engine with both at stoichiometric fuel-air ratios. An adiabatic model, confirmed by experimental data, for the combustion and burnt gas expansion processes, is described. It was developed to estimate nitric oxide (NO) emissions from a hydrogen-fueled engine. With hydrogen fuel, very lean mixtures can be used for part load operation and low levels of NO can be obtained. Techniques such as exhaust gas recirculation and spark timing retard can also be used for NO control in hydrogen-fueled engines. It is concluded that, from a performance and emissions standpoint, a spark ignited reciprocating engine operating unthrottled with direct cylinder injection of hydrogen fuel is an attractive transportation powerplant for the future.

by William J. McLean; Jean-Jacques Fagelson
Cornell Univ., Ithaca, N.Y. 14850
Contract DOT-OS-30113
Publ: HS-017 654 (DOT-TSC-OST-75-31) Automotive Energy
Efficiency Prog., Cambridge, Mass., 1975 p233-53
1975 ; 42refs
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Mass.
Availability: In HS-017 654

HS-017 672

HYDROGEN CAR DEVELOPMENT

Experimental investigations relative to hydrogen car development are reviewed. A comparative study of the performance of a 1973 Chevrolet 350 cubic inch displacement, V-8 engine indicated thermal efficiencies of from 25 to 100% greater with hydrogen than with gasoline. The emission of nitrogen oxides

was reduced approximately 90% when operating on hydrogen. With quality governed, hydrogen operation, however, maximum power output is reduced by as much as 50%, and with water injection, perhaps 30%. The kinetics and mechanism of magnesium alloy-hydride formation and dissociation are examined. The process is found to be diffusion controlled. Magnesium-10 aluminum hydrides containing 7% hydrogen by weight are formed. This alloy did not show excessive fragmentation on cycling and would seem the only one potentially useful in transportation systems, although its temperature-pressure equilibrium condition is less than favorable. A liquid hydrogen system was developed and installed in a 1973 Jeep. It employed a storage and delivery system developed using liquid hydrogen and appropriate cryogenic technology and was found to be feasible. The system's operating experience thus far is favorable.

by William D. Van Vorst
University of California, Los Angeles, Calif.
Publ: HS-017 654 (DOT-TSC-OST-75-31) Automotive Energy Efficiency Prog., Cambridge, Mass., 1975 p253-65
1975 ; 3refs
Presented at the meeting held 15-17 Jan 1975, at Cambridge, Mass.
Availability: In HS-017 654

HS-017 673

EFFECT OF COMMERCIAL VEHICLE SYSTEMATIC PREVENTIVE MAINTENANCE ON SPECIFIC CAUSES OF ACCIDENTS. FINAL REPORT

A program designed to determine the effect of proper commercial vehicle inspection and maintenance procedures on safety and to document the need for improved or modified inspection and maintenance requirements is presented. Data sources include: the current technical literature, existing accident and population data, surveys of regulatory personnel and agencies, meetings with trucking industry personnel concerned with inspection and maintenance, and a collection of supplemental accident information (interviews with drivers in vehicle defect-related accidents and comparison with non-defect accidents). Data were put into digital form and it is concluded that there is an identifiable relationship between good inspection and maintenance practices and a reduction in defect-related accidents; in addition, the better maintenance practices are usually associated with the larger firms and poorer practices are associated with the smaller firms or individuals. The principal accident-causing defects identified in this study are visually detectable: tires, brakes, lights, and wheels. The most important factor in reducing the incidence of defect-related accidents is detection of the defect. It is recommended that the current practices of the better motor carrier with respect to vehicle inspection be formalized and enforcement and education activities of the Bureau of Motor Carrier Safety be expanded.

by Thomas L. McDole; James O'Day
University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich. 48105
Contract DOT-FH-11-8272
Rept. No. UM-HSRI-SA-75-13 ; 1975 ; 137p 67refs
Rept. for 1 Jan 1974-31 Jul 1975.
Availability: Federal Hwy. Administration, Bureau of Motor Carrier Safety, Washington, D.C. 20590

HS-017 674

IMPEDIMENTS TO THE EVALUATION OF HIGHWAY SAFETY PROGRAMS

The problem of effective evaluation of highway safety programs is discussed. The definition, history, and internal and external impediments of safety program evaluation are examined. An idealized model for carrying out effectiveness evaluations and several examples of well-designed and well-conducted evaluations are presented. The most frequent and crucial impediments in the area of highway safety evaluation are seen to be: a lack of understanding of evaluation; an unwillingness to have programs undergo evaluation if an understanding of the process does exist; a paucity of trained personnel to carry out evaluations; and the existence of inadequate tools, procedures, and data bases for establishing sound evaluative research procedures. Recommendations are made detailing ways in which these deficiencies might be overcome and future highway safety evaluations improved.

by Lindsay I. Griffin, III.; Brian Powers; Catherine Mullen
University of North Carolina, Hwy. Safety Res. Center, Chapel Hill, N.C.
Contract MVMA-UNC-7404-C5.1
1975 ; 79p 38refs
Availability: Corporate author

HS-017 675

PLASMA JET IGNITION OF LEAN MIXTURES

The development of a plasma jet ignition system on a 4-cylinder, 140 cubic inch engine is described. Performance was evaluated on the basis of combustion flame photographs in a single-cylinder engine at 20 to 1 air-fuel ratio dynamometer tests on a modified 4-cylinder engine, and cold start emissions, fuel economy, and driveability in a vehicle at 19 to 1 air-fuel ratio. System electrical and mechanical parameters were varied to improve combustion of lean mixtures. For example, the air-fuel ratio range was 16 to 1 - 22 to 1, secondary ignition current was varied from 40 to 6000 mA, and plasma jet cavity and electrode geometry were optimized. It is shown that the plasma jet produces an ignition source which penetrates the mixture ahead of the initial flame front and reduces oxides of nitrogen emission, in comparison to a conventional production combustion chamber. The reduction in oxides of nitrogen is attributed to decreased gas residence time at high temperatures and a lower gas temperature history.

by Floyd A. Wyczalek; Daniel L. Frank; John G. Neuman
General Motors Corp., Engineering Staff
Rept. No. SAE-750349 ; 1975 ; 15p 14refs
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.
Availability: SAE

HS-017 676

DESIGN, FUNCTION, AND APPLICATION OF IONIZING GAPS FOR IGNITION SYSTEMS

The effect of ionizing gaps in coil ignition systems in laboratory and road tests is described. The results obtained from coil ignition systems with ionizing gaps are compared to those from standard coil ignition and capacitive discharge ignition systems. The requirements of ionizing gaps for vehicle application are outlined. Tests included: laboratory measurements of

the secondary available voltage at the coil ignition system, with and without the ionizing gaps, and at the capacitive discharge ignition system; cold chamber tests at coolant temperatures of -20°C with several types of 4-cylinder engines comparing a coil ignition system with nine kilovolt ionizing gaps and standard coil ignition system; short distance/low-load tests with frequent engine stops and cooling-downs run at 0°C ambient temperature; and engine tests to determine the effect of ionizing gaps on buildup of spark plug deposits (a 6-cylinder fuel-injection engine run with three cylinders using a coil ignition system and three cylinders operated with 14 kilovolt ionizing gaps to measure the variation in shunt path resistance, a similar engine test to determine the rate of misfiring while idling for the two categories of cylinders operated with and without ionizing gaps, a low speed/low load road test, and a full load highway test). The design and characteristics of Bosch-ionizing gaps are discussed. It is concluded that: the ionizing gap has proven to be a very effective and reliable element for solving spark plug deposit problems; the particular advantage of coil ignition systems with ionizing gaps compared to capacitive discharge systems is a much longer spark duration favorable for lean mixture inflammation; the gradient of voltage ascent at the spark plug is much larger than with the capacitive discharge ignition system; and, in addition to a low source impedance, the system with ionizing gaps shows an effect of reducing spark plug deposits.

by Harald Mauch
Robert Bosch, GMBH., West Germany
Rept. No. SAE-750350 ; 1975 ; 8p 3refs
Presented at the Automotive Engineering Congress and
Exposition, Detroit, Mich., 24-28 Feb 1975.
Availability: SAE

HS-017 677

THE BIG FREEZE IS COMING [WINTER CAR MAINTENANCE]

Proper automobile care during and preparation for winter weather are discussed. The need for a general tune-up, battery checks, and warm-up time before engine operation in cold weather is emphasized. The proper care to be given to the following automotive systems is considered: the cooling system, the exhaust system, the brakes, the tires (chains), the heating - defrosting - defogging equipment, and the windshield wipers.

Publ: Driver v9 n5 p1-7 (Oct 1975)
1975
Availability: See publication

HS-017 678

A BUMPY ROAD AHEAD? [SPEED BUMPS]

The potential effectiveness of various types of speed bump configurations in reducing vehicle speeds was evaluated: 3 rounded bumps (2 inches high by 8 inches long, 3 inches high by 2 feet long, and 3 inches high by 8 inches long); and 3 30° ramped bumps (2 inches high by 6 inches long, 2 inches high and 3 feet long, and 3 inches high by 6 inches long). Eleven vehicles were selected for the study, most of them representative of the type of traffic to be found on the residential streets on which the bumps were proposed: a Schwinn Continental bicycle; a 750cc Honda, a 250cc Honda; a 1973 Chevrolet Vega; a 1969 Ford Galaxie 500; a Volkswagen bug; a 3/4-ton pickup truck; a Dodge van; a 2-ton International Harvester

dump truck; a Ford 1,000-gallon-per-minute fire truck; and an International Harvester two-axle police bus. Five test speeds, from 5 to 45 mph in 10 mph increments, were selected. Two trained observers and a trained driver were used in all test runs (except the motorcycle and bicycle tests). The observers recorded the level of discomfort for each test run. Noise level meters, vertical accelerometers and a movie camera were used to record the events. It is concluded that: the speed bumps tested are not effective in reducing vehicle speed; speed bumps produce an immediate and specific hazard to motorcycles and bicycles and a potential hazard to all vehicles; it is impossible to design an effective, narrow speed bump for all types of vehicles; and speed bumps would cause noise pollution in residential neighborhoods.

by Charles D. Allen; Lawrence B. Walsh
Publ: Traffic Engineering v45 n10 p11-4 (Oct 1975)
1975 ; 1ref
Availability: See publication

HS-017 679

MULTIVARIATE PREDICTION OF DRINKING DRIVERS [OREGON]

Two multivariate procedures, Automatic Interaction Detection (AID) and step-wise multiple regression, employed to predict drinking driving traffic offenses (DUIL), are described. Prediction variables included: driver age, prior traffic citations and reportable accidents; criminal record; and questionnaire items. The questionnaire included four scales: demographic data (marital status, family income, education, occupation, and an index of socio-economic status); alienation and maladjustment; impulsivity and non-conformity; and attitude toward drinking. Two samples of driver improvement interviewers (781 in all) were selected, one with and one without a subsequent DUIL, matched by age, sex, and time and place of the interview. Driving and criminal records were obtained. Members of both groups were sent questionnaires. Results of the multivariate analyses included: prediction accuracy varied from two out of three to slightly better than three out of four; and the best individual predictors were social position, marital status, selected questionnaire items from the impulsivity-non-conformity and attitude toward drinking scales, the latter scale overall score, and family income. It is concluded that the AID-predictions are more accurate than those from the step-wise regression model.

by Noel Kaestner; Laurie Speight
Oregon Dept. of Transportation, Motor Vehicles Div.
1975 ; 69p 11refs
Supported in part by the National Hwy. Traffic Safety
Administration under Hwy. Safety Proj. no. 36-74-310. Cover
title: Oregon Multivariate Prediction.
Availability: Oregon Dept. of Transportation, Div. of Motor
Vehicles, Salem, Oregon

HS-017 680

REVIEW AND ANALYSIS OF GASOLINE CONSUMPTION IN THE UNITED STATES FROM 1960 TO THE PRESENT. FINAL REPORT

The monthly gas consumption data (January 1960-April 1974) for each of the 50 states and the District of Columbia are presented and analyzed. Included is a series of charts containing a regression analysis performed on the selected data for

each state, growth rates for each state, and a ranking of the state with respect to 1960 and 1972 gas consumption totals and compound growth rates (1960-1972). Also included is a series of graphs depicting monthly gas consumption for each state.

by Helen Connell; Rita Folan
Transportation Systems Center, Kendall Square, Cambridge,
Mass. 02142
Rept. No. DOT-TSC-OST-74-43 ; 1975 ; 51p
Rept. for Jan 1960-Apr 1974.
Availability: NTIS

HS-017 681

ENGINE PERFORMANCE TEST OF THE HONDA CVCC. INTERIM REPORT

Data obtained from a test of a prototype Honda CVCC, 90.8 cubic inch, 4-cylinder engine are presented. The engine was mounted on a test stand and coupled to an eddy-current dynamometer and an electric motor used for both starting and motoring the engine. Total engine operating time (break-in and testing) was 160 hours. The engine was operated at the following steady state modes: low speeds (1,000; 1,500; 2,000; and 2,500 rpm); high speeds (3,500; 4,500; and 5,500 rpm); and idle (no load). The data included are sufficient to establish the steady-state engine maps for fuel consumption and emissions (hydrocarbons, carbon monoxide, and nitric oxides) over the engines entire operating range: test number, data, barometric pressure, dew point, inlet air temperature, speed, torque, fuel rate, ignition timing, manifold vacuum, throttle angle, percentage of oxygen, emissions percentage, oil temperature and pressure, coolant temperature, and exhaust temperature and pressure.

by W. F. Marshall
Energy Res. and Devel. Administration, Bartlesville Energy
Res. Center, P. O. Box 1398, Bartlesville, Okla. 74003
Contract RA-75-10
Rept. No. DOT-TSC-OST-75-30 ; 1975 ; 48p
Rept. for Jan 1975.
Availability: NTIS

HS-017 682

THE HUMAN COLLISION. HOW INJURIES OCCUR...HOW SEAT BELTS PREVENT THEM

The phenomena of human collisions in automobile accidents are examined, and the ability of seat belts to prevent them is discussed. The car's collision, the human collision with the interior of the car, and person-to-person collisions are considered. The dynamics of the situation of an automobile collision are discussed and seat belts' alleviation of these forces is explained (laboratory evidence and evidence from real accidents). Other accident factors considered are the dangers of being thrown clear, the importance of remaining conscious, and the importance of being properly belted and wearing the belts at all times. Color photographs of barrier and sled crash tests and actual accident-involved vehicles and drawings of the vehicle and occupant dynamics during collision impacts with and without seat belt usage are provided.

by Lawrence Lonero; Kathryn Stephen
Ontario Ministry of Transportation and Communications, 1201
Wilson Ave., Downsview, Ont. M3M 1J8, Canada
1975 ; 23p 32refs
Availability: Corporate author

HS-017 683

THE 50 M.P.H. SPEED LIMIT

The first year's operation (December 4, 1973-December 4, 1974) of the 50 mph speed limit on New Zealand highways is reviewed. The lowered speed limit was introduced as a fuel conservation measure and was followed by a reduction in operating speeds of 8-10 mph. After that time speeds gradually increased again, but, over the last few months of 1974, tended to stabilize at about 2-5 mph below pre-50 mph limit levels. There were 9% fewer accidents in the year following the new speed limit law by comparison with the previous year. For all casualties the reduction was greater in 50 mph areas (19%) than in areas less than 50 mph (6%). Other factors, besides the 50 mph speed limit, contributing to the accident reduction are discussed: lower fuel consumption, even with some growth in traffic volume; compulsory motorcycle helmet wearing law (for speeds over 30 mph); more widespread use of seat belts; and smoother driving and increased enforcement.

by J. B. Toomath
Ministry of Transport, Traffic Res. Sec., Private Bag,
Wellington, New Zealand
Rept. No. Traffic-RR-12 ; 1975 ; 22p 6refs
Presented at the 46th General Scientific Meeting of the Royal
Australasian Coll. of Surgeons, Queenstown, Australia, Aug.
1975.
Availability: Corporate author

HS-017 684

TRAFFIC SAFETY RESEARCH IN NEW ZEALAND

The current organization of traffic safety research in New Zealand is reviewed. The research impetus provided by government as a result of recommendations of the 1972 Parliamentary Select Committee on Road Safety is considered and the functions of the principle organizations involved are outlined. Research implications for the medical profession are discussed.

by J. B. Toomath
Ministry of Transport, Traffic Res. Sec., Private Bag,
Wellington, New Zealand
Rept. No. Traffic-RR-13 ; 1975 ; 14p 8refs
Presented at the 46th General Scientific Meeting of the Royal
Australasian Coll. of Surgeons, Queenstown, Australia, Aug.
1975.
Availability: Corporate author

HS-017 685

PSYCHOLOGICAL STUDIES OF THE HAZARDOUS DRIVER REPORT

Three independent studies of groups of drivers known for their over-involvement in traffic accidents (elderly drivers, repeated offenders, and young drivers below the age of 25) are described. A total of 66 paid volunteers over the age of 60 (34 males and 32 females) was examined for about 3 hours each. The following kinds of data were collected: living circumstances, driving history; use of alcohol; general health; mental health, psychological tests, mostly for memory; visual examinations, including field of vision and glare recovery; and, for selected subjects, performance on simulated driving tasks reaction time, critical tracking time and vigilance tasks. A case by case analysis of 66 incarcerated problem drivers (11 vehicu-

lar manslaughter subjects matched with 11 inmates convicted for nonvehicular manslaughter, and 22 habitual offenders matched with 22 vehicular-misdemeanors-not-habitual offenders) was conducted using data from medical examinations, psychological examinations, social histories, educational-achievement assessments and driving conduct. Three separate studies of young drivers were conducted: 54 male employees of Duke University, aged 18-25, were given a personality interview, and a series of personality/psychological tests to try to isolate a single psychological instrument to identify hazardous drivers; 225 18-25 year old males were selected by driving record (1/2 had unblemished records for 3 years, and the others had received warning letters, suspension, and/or revocation in the same 3 years) and been given a traffic screening test; and 61 women, aged 19-64, and 69 men, aged 19-70, were given the same traffic screening test. It was found that: the deteriorating older driver can probably be effectively identified by rapid, safe, and objective means; the group of habitual offenders exhibit a tendency towards marginal social adaptation; both groups of felon-drivers exhibit much social turbulence; in young drivers drinking and number of drinks at a sitting were unrelated to recorded self-reported accidents but significantly related to recorded and self-reported violations; for women, the greater the annual miles driven, the more the accidents and the more daily miles driven, the higher the number of violations; the more drinks per sitting, the greater the number of violations; and for men and women, the greater the numbers of accidents, the greater the number of violations. High school students have been given a traffic screening test and, in four years, their driving records will be examined and analyzed for relationships with their previous testing results.

National Driving Center, 255 Engineering Annex, Duke Univ., Durham, N.C. 27706
1975 ; 109p 20refs

Prepared for the State of North Carolina in cooperation with the North Carolina Dept. of Motor Vehicles and the North Carolina Governor's Hwy. Safety Prog.
Availability: Corporate author, \$6.00

HS-017 686

AN EVALUATION OF NORTH CAROLINA'S MULTI-VEHICLE RANGE PROGRAM IN DRIVER EDUCATION: A COMPARISON OF DRIVING HISTORIES OF RANGE AND NON-RANGE STUDENTS

The 18 multi-vehicle driving range laboratories in North Carolina and their effectiveness as tools in the driver education system are evaluated. The accident experience of two samples of students were compared (1644 receiving driving range training and 1759 receiving standard training). Information collected for both groups included full name, address, birthdate, sex, race, and I.Q. and/or grade point average. Driving records were examined for the groups over a two-year period which was divided into six-month intervals to obtain the following variables: number of total accidents; number of injury accidents; number of non-injury accidents; number of at-fault accidents; and number of total violations. Three other variables were also calculated: the subject's age at time of licensing; the elapsed number of days to first accident; and the elapsed number of days to first violation. It was found that: there were few significant accident-history differences between the range and the non-range group; in the non-white male subset, a higher proportion of range-trained students were involved in accidents; and if there was any trend, it was

toward the range group accumulating a higher number of violations. Limitations of the present study are pointed out and recommendations for improving the range program are provided.

by Forrest M. Council; Rita B. Roper; Michael G. Sadof
University of North Carolina, Hwy. Safety Res. Center, Chapel Hill, N.C.

1975 ; 65p 9refs

Supported by the North Carolina Governor's Hwy. Safety Prog. as part of the "Driver Education Evaluation and Curriculum Modification" proj. (304-75-001-001)

Availability: Corporate author

HS-017 687

IMPACT CONSIDERATIONS OF THE NATIONAL 55 MPH SPEED LIMIT (BACKGROUND), INTERIM REPORT

The causes and effects of the 55 mph national speed limit are reported. An overview of the governmental deliberation rationale and actions which led to the adoption of the limit are provided. Also examined and discussed are: physical and economic impacts of the 55 mph limit (fuel savings, traffic safety, related impacts on consumers and transportation industry impacts); and social impacts (state police and government leader reactions, public response, foreign experience, individual impacts, and impacts on organizations, groups, social institutions and values). It is concluded that: the 55 mph speed limit improves the quality of life of individuals by saving lives and energy for other purposes, but it reduces the quality of life of individuals by increasing their travel time and reducing time for other activities; the impacts on organizations and groups are generally negative but smaller than some of the groups expected; the impacts on institutions and values are generally positive; and the impact on the American way of life is positive in the sense that it shifts that way of life in a direction more conducive to present and projected conditions in this society.

Braddock, Dunn and McDonald, Inc., 1920 Aline Ave., Vienna, Va. 22180

Contract NSF-C934 (AER-74-22522)

Rept. No. BDM/W-74-065-TR ; 1974 ; 316p 278refs

Availability: National Science Foundation, 1800 G St., N.W., Washington, D.C. 20036

HS-017 688

CRASH HELMETS REDUCE HEAD INJURIES

Three different samples of automobile accident injuries were studied to determine injury patterns of motorcyclists, motor-scooter drivers and passengers admitted to hospitals or killed in Brisbane, Australia, before and after the introduction of compulsory crash helmet usage legislation in 1970. The samples include: 151 motorcyclists injured or killed between January, 1962, and May, 1963; 38 motorcyclists injured or killed in November and December of 1971 (the first full year of compulsory helmet usage); and a sample of 65 motorcycle accident victims injured or killed in December, 1972, and January, 1973. The major changes in the samples taken before and after the legislation were a major rise in helmet usage, and a significant fall in the incidence of head injury. Failure of the legislation to reduce the death rate may be due to both the frequent coexistence of other lateral lesions and possibly an increased severity of impacts due to change in motorcycle

power and speed. A saving of 10 major and 14 minor head injuries was experienced in less than 4 months; constituting a morbidity reduction of 1/3 of the 29 major head injuries that might have been expected. If extrapolated to the general population of Australia, this would represent a saving of 390 major and 156 minor head injuries per year.

by Kenneth G. Jamieson; D'Arcy Kelly
Publ: Medical Journal of Australia v2 n17 p806-9 (27 Oct 1973) 1973; 6refs

Availability: See publication; Kenneth G. Jamieson, Royal Brisbane Hosp., Brisbane Base Hosps. P.O., Brisbane, Qld. 4029, Australia

HS-017 689

**THE PERCEPTION OF MANOEUVRES
[MANEUVERS] OF MOVING VEHICLES. PROGRESS
REPORT NO. 1. EFFECTS OF VIEWING DISTANCE
AND ANGULAR SEPARATION**

The movements of the tail lights of a leading vehicle in night time driving were simulated using a four dimensional repeated measurement design. Four variables were manipulated: initial angular separation (2°, 1°, 30 minutes, 15 minutes, and 7.5 minutes); exposure duration (4, 2, 1, and 0.5 seconds); direction of movement (in and out); and presence of a background. Twenty-four subjects, each seated in a chair 25 meters from a screen on which the lights were projected, were required to judge whether the lights were moving in or out relative to each other. It was hoped that the speed of movement of which the subject could detect the movement 75% of the time (called a threshold) could be determined. Each subject was presented the stimulus lights 40 times at one simulated speed. Linear speed motion thresholds (kilometers per hour), angular velocity thresholds (minutes of arc per second), and total angular movement were determined as functions of the four variables. It was found that: background has no effect on the thresholds; and angular separation of the spots of light, exposure duration, and direction of movement all have significant effects.

by Lewis O. Harvey, Jr.; John A. Michon
Institute for Perception TNO, P.O. Box 23, Kampweg 5, Soesterberg, Netherlands
Rept. No. 1971-C6; PR-1; 1971; 38p 18refs
Sponsored by the Inst. for Road Safety. Includes Dutch summary. See also PR-2 (HS-017 690); PR-3 (HS-017 691); PR-4 (HS-017 692); PR-5 (HS-017 693); and PR-6 (HS-017 470).
Availability: Corporate author

HS-017 690

**THE PERCEPTION OF MANOEUVRES
[MANEUVERS] OF MOVING VEHICLES. PROGRESS
REPORT NO. 2. EFFECT OF LATERAL MOTION ON
THRESHOLDS FOR RELATIVE SAGITTAL MOTION**

The movements of the tail lights of a leading vehicle in night driving making an angle with the subject's head were simulated. Each of 24 students were required to judge whether the lights (projected on a screen 25 meters away from the seated subject) moved relative to one another, the sagittal motion component in lateral motion. The relative motion thresholds (at which the subject can detect motion 75% of the time) were determined for the following variables: exposure time, viewing distance, and lateral motion speed. It is concluded that: the de-

tectability of relative sagittal motion away from the observer is seriously impaired when lateral motion is added; kilometer per hour thresholds increase with decreasing initial angular separation between the lights or with decreasing exposure time; the necessary sensory information for detection of relative sagittal motion when lateral motion is added appears to be a fixed angular distance travelled during the first second of observation; the particular size of this distance being only a function of lateral speed and of initial angular separation; and the maximum angle between the heading directions of the leading and the following car at which detection of relative sagittal motion is possible increases with increasing speed, with increasing exposure time and with increasing initial angular separation.

by W. H. Janssen
Institute for Perception TNO, P.O. Box 23, Kampweg 5, Soesterberg, Netherlands
Rept. No. IZF-1971-C20; PR-2; 1971; 26p 4refs
Sponsored by the Inst. for Road Safety. Includes Dutch summary. See also PR-1 (HS-017 689); PR-3 (HS-017 691); PR-4 (HS-017 692); PR-5 (HS-017 693); and PR-6 (HS-017 470).
Availability: Corporate author

HS-017 691

**THE PERCEPTION OF MANOEUVRES
[MANEUVERS] OF MOVING VEHICLES. PROGRESS
REPORT NO. 3. DIRECT SCALING OF
TRANSLATORY VELOCITY, ANGULAR DISTANCE
AND ANGULAR VELOCITY OF LIGHTS**

A number of experiments (with 24 students as subjects, seated 25 meters from a project screen) on subjective scales for some important physical variables in configurations of tail lights in darkness are reported. By means of the method of magnitude estimation with a standard stimulus arbitrarily assigned, the magnitude "100" scales were determined for the following variables: translatory velocity of a single light; translatory velocity of two lights; velocity of approach of two lights; velocity of recession of two lights; and angular separation between two stationary lights. As a check on the results some experiments were replicated with the standard stimulus assigned the magnitude "10" (using 20 research employees as subjects). It was found that: the scales for translatory velocity of two lights and a single light are very similar, and, in either case, there is a considerable autokinetic movement effect; considerable autokinetic movement effects are found for the velocity of approach and recession of two lights; the exponent of the power function (of the mapping of the subjective scale) is much smaller for movements simulating a receding car, the size of the difference in exponent being dependent on the viewing distance; and there is practically no autokinetic effect for the angular separation between two stationary lights.

by W. H. Janssen; J. A. Michon; M. Buist
Institute for Perception TNO, P.O. Box 23, Kampweg 5, Soesterberg, Netherlands
Rept. No. IZF-1971-C18; PR-3; 1971; 47p 22refs
Sponsored by the Inst. for Road Safety. Includes Dutch summary. See also PR-1 (HS-017 689); PR-2 (HS-017 690); PR-4 (HS-017 692); PR-5 (HS-017 693); and PR-6 (HS-017 470).
Availability: Corporate author

HS-017 692

**THE PERCEPTION OF MANOEUVRES
[MANEUVERS] OF MOVING VEHICLES. PROGRESS**

REPORT NO. 4. PERCEPTIBILITY OF RELATIVE SAGITTAL MOTION ON THE BASIS OF CHANGES IN APPARENT SIZE OR BRIGHTNESS OF TAILLIGHTS

The perceptibility of relative motion in depth (sagittal motion) of a stimulus light is studied as a function of the angular subtense of the light at onset, the exposure duration, and the direction of movement (direct approach or recession). A light source was projected onto transparent red foil from behind as a flat circular image. The relevant perceptual cue for the 24 student subjects was a change in either the apparent size or brightness of the light accompanying a change in viewing distance. It was found that: changes in apparent size and brightness of taillights are ineffective cues in the detection of relative sagittal movement; and much more effective as a perceptual cue are changes in angular separation between lights accompanying relative sagittal movement. It is concluded that size-brightness cues may be left out of consideration in future theorizing on problems of detectability of taillights in night driving.

by W. H. Janssen
Institute for Perception TNO, P.O. Box 23, Kampweg 5, Soesterberg, Netherlands
Rept. No. IZF-1972-C6; PR-4; 1972; 23p 20refs
Sponsored by the Inst. for Road Safety. Includes Dutch summary. See also PR-1 (HS-017 689); PR-2 (HS-017 690); PR-3 (HS-017 691); PR-5 (HS-017 693); and PR-6 (HS-017 470).
Availability: Corporate author

HS-017 693

THE PERCEPTION OF MANOEUVRES [MANEUVERS] OF MOVING VEHICLES. PROGRESS REPORT NO. 5. THRESHOLDS FOR RELATIVE VEHICLE MOTION IN DEPTH: A CHECK IN THE FIELD

The conclusion previously drawn from laboratory experimentation, that a change in angular separation between a vehicle's taillights, rather than a change in their apparent size or brightness, is the cue in detection of relative vehicle motion in depth, was tested in a field situation. Three female and one male subject (research employees) were driven in a Peugeot 404 (two subjects at a time) behind a DAF 55 (the leading car) with taillights 98 centimeters apart) on a 1200 meter straight stretch of asphalt road at night. Radio communication between the vehicles was maintained. Experimental conditions included: direction of motion (away and toward); viewing distance (112 and 224 meters); exposure interval (1 or 2 seconds); speed of following car (27 and 57 kilometers per hour); and speed of leading car (27-60, 27-47, 27-72, 57-21, 57-46, and 57-11 kilometers per hour). Forty runs were made under each condition. The results were in agreement with the conclusion made from laboratory experimentation.

by W. H. Janssen
Institute for Perception TNO, P.O. Box 23, Kampweg 5, Soesterberg, Netherlands
Rept. No. IZF-1973-C12; PR-5; 1973; 12p 4refs
Sponsored by the Inst. for Road Safety. Includes Dutch summary. See also PR-1 (HS-017 689); PR-2 (HS-017 690); PR-3 (HS-017 691); PR-4 (HS-017 692); and PR-6 (HS-017 470).
Availability: Corporate author

HS-017 694

EFI PRECHAMBER TORCH IGNITION OF LEAN MIXTURES

The development of a prechamber-type torch ignition system on a modified 4-cylinder, 140 cubic inch engine is described. The prechamber, in this system, produces an ignition torch which ignites a main chamber supplied with a lean mixture carbureted in the conventional manner. The performance of this combustion concept was evaluated on the basis of vehicle driveability, exhaust emissions, and fuel economy in a 3000 pound weight class vehicle. In addition to adjustable engine variables, such as air fuel ratio and spark advance, electronic fuel injection and mechanical parameters were varied to improve combustion of lean mixtures. For example, the carbureted main chamber air fuel ratio was explored from 18-26:1, the prechamber fuel injection rate was varied by modulating injector pulse width, and fuel injection timing was evaluated during the exhaust, intake and compression strokes. The electronic fuel injection torch ignition concept produces an ignition source which penetrates and inflames the lean mixture in the main chamber and increases the rates of combustion substantially (reduces typical road load spark advances by about 18°). It also reduces carbon monoxide and nitrogen oxides, although hydrocarbon emission is increased. A computer analysis of the physical processes of prechamber mixing, helpful in guiding experimental work, is discussed.

by F. A. Wyczalek; J. L. Harned; S. Maksymiuk; J. R. Blevins
General Motors Corp., Engineering Staff
Rept. No. SAE-750351; 1975; 16p
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.
Availability: SAE

HS-017 695

ACCIDENT ANALYSIS PROCEEDINGS OF P.T.R.C. SUMMER ANNUAL MEETING, SEMINAR, 25-29 JUNE, 1973, UNIVERSITY OF SUSSEX, [ENGLAND] (STREAM J)

Many different aspects of automobile accidents are analysed. The use of engineering methods to reduce traffic accidents is discussed. The accident identification system used by the police in the London area is described. The identification, analysis, and treatment of traffic accident black spots in the London area is discussed. The use of the OSIRIS package in the analysis of traffic accidents is examined. An experiment conducted in Denmark was designed to determine the effects of police enforcement of traffic laws on accidents. Methods used to record traffic accident data in Denmark are described. Reports from 24 British counties and major cities indicate that a variety of systems are used for processing data related to traffic accidents and that remedial action is approached in several ways. The accident recording and analysis system used by the Gloucestershire County Council is discussed, as is the system used by the Cornwall County Council. The West Riding County Council is investigating computerized options for improved traffic accident data collection and analysis. Reports from the Transport and Road Research Laboratory on the role of traffic conflict in traffic accidents, accidents and traffic conflicts at junctions, and road accidents in darkness are summarized. The use of accident analysis in improving vehicle design to prevent accidents is examined. The effect of stability characteristics of different models of cars on the likelihood of having an accident which involves overturning was investigated. The role

of alcohol and other drugs in traffic accidents was examined and the effects of legislation in this area on traffic accidents was discussed.

Planning and Transportation Res. and Computation Co., Ltd., 167 Oxford St., London, W.1., England
 Rept. No. PTRC/P/84; 1973; 169p refs
 On cover: Includes HS-017 696-HS-017 708. Also includes abstracts of Transport and Road Res. Lab. repts.: LR-514 (HS-012 524); LR-536 (HS-012 881); and LR-461 (HS-012 152).
 Availability: Corporate author

HS-017 696

STRATEGIC THINKING ON ACCIDENT PREVENTION BY ENGINEERING METHODS

The reorganization of local government in Great Britain provides the opportunity for the Hertfordshire County Council to reconsider the principles and organization required to effectively reduce traffic accidents by engineering methods. An accident data computer system and specialized remedial action systems were introduced in the County in 1967, providing valuable information which can be used in designing effective accident prevention systems. The reorganized local government in the County will show greatly increased activity on accident prevention and in management control systems. Management control systems focus attention on objectives and methods. Research should be conducted on the correlation of circumstances criteria with great potential benefits in terms of accident prevention. Based on present limited data, an overall target of a 12.5% accident reduction from the expected accident rate is recommended. An annual expenditure of 900,000 pounds sterling would be justified to provide and maintain that standard. The present methods of attacking accidents were found to be inadequate, not encountering enough accidents to achieve the objective. Selected sites with a repeated pattern of certain types of accidents should be studied to determine the remedial actions required to reduce the accident rate. Various accident blackspot identification criteria, types of work pressure, and the need for before and after studies are discussed.

by J. L. S. Wilson
 Hertfordshire County Council, England
 Publ: HS-017 695 (PTRC P 84), Accident Analysis, London, 1973
 Rept. No. J12; 1973; 13p 25refs
 Presented at the P.T.R.C. Seminar held at the Univ. of Sussex, England, 27-29 Jun 1973.
 Availability: In HS-017 695

HS-017 697

THE METROPOLITAN POLICE ACCIDENT INTELLIGENCE SYSTEM

The London, England, Metropolitan Police District is responsible for about 8,700 miles of road networks over which more than 40 million vehicle miles are travelled each day. The metropolitan police accident intelligence system gathers and processes data necessary to justify the deployment of limited police personnel for accident prevention purposes in the most effective manner. The basic information required is the relevant traffic data and current accident figures. This data is now available for about 4,000 intersections in the district, with 20 new sites being added each month. The accident prevention unit attempts to eliminate a given accident situation through modification of an individual's behavior so that the individual

will not contribute to the problem or through modification of the individual's environment so as to minimize both the likelihood and the consequences of unsafe behavior or driver error. The Accident Prevention Unit, which was created in August 1971, consists of eight teams of experienced traffic patrol officers, including a woman police constable, under the command of a police sergeant. Each officer is a qualified vehicle examiner, and, as far as possible, the teams seek to attain their objective of reducing accidents at the classified sites through advice, warning, and guidance. An accident study card for each location, which tabulates the accident history and provides an elemental collision diagram illustrating the maneuver associated with each accident, is made available to the teams prior to taking up an assignment. Before and after statistics for sites receiving the concentrated attention of the unit indicate a proportional accident reduction of about 23%.

by J. C. Cutts
 New Scotland Yard, Traffic Dept., England
 Publ: HS-017 695 (PTRC/P/84), Accident Analysis
 Rept. No. J13; 1973; 9p 3refs
 Availability: In HS-017 695

HS-017 698

SELECTION, ANALYSIS AND TREATMENT OF ACCIDENT BLACK SPOTS IN URBAN AREAS

The techniques used for a rapid and rational selection of black spots, particularly the use of Mass Action Plans (MAPS) produced by a computer to seek sites throughout the Greater London Council area having problems amenable to specific solutions, are discussed. The computerized accident statistics system is based on node-link-cell orientation with the location of each traffic accident defined by eight figure grid reference and provides data on accidents by location and type, as well as maps of specific types of accidents to any scale. The basic aim of analysis of black spots is to try to identify factors which influence accident risks which are common to a group of accidents, so that remedies can be designed to eliminate the risks, or at least to substantially reduce them. Once the factors contributing to high accident risk have been identified using the computerized system, sites are visited and important features are carefully recorded. Remedial measures are then formulated and their effectiveness estimated, with the main objective being the quickest possible implementation of safety measures. When a new tool or remedy has been found effective in a number of locations, the computer system permits a search of all files with a potential application of this remedy. Applications of the MAPS have included: the use of 'Shell-grip', which has a much higher skid resistance and lower tendency to polish than alternative road surfacing (on approaches to junctions and pedestrian crossings); improved lighting schemes; improved signs or improvements in visibility and junction design at junctions controlled by yield or stop signs; junction safety signs prohibiting parking or stopping for loading or unloading within a specified distance from the junction; and the creation of 'ghost islands' on certain streets. An analysis of the MAPS schemes which have been in operation for 6 months or longer indicates that accidents are being reduced by about 30% and that the first year rate of return on safety schemes exceeds 150%.

by L. A. Swali

Greater London Council, Traffic and Devel. Branch, London, England

Publ: HS-017 695 (PTRC/P/84), Accident Analysis, London, 1973

Rept. No. J14; 1973; 15p 4refs

Presented at the P.T.R.C. Seminar held at the Univ. of Sussex, England, 27-29 Jun 1973.

Availability: In HS-017 695

HS-017 699

THE USE OF THE "OSIRIS" PACKAGE IN THE ANALYSIS OF ACCIDENT DATA

The application of a set of computer programs, the Organised Set of Integrated Routines for Investigation with Statistics (the OSIRIS package), to the analysis of traffic accident data is discussed. This system was developed by the Institute of Social Research and the Interuniversity Consortium for Political Research, both at the University of Michigan. OSIRIS programs include: data management programs, which are used to clean and rewrite the data to a format which is suitable for input to the statistical analysis program; and statistical analysis programs, which can produce tables of accident statistics, partial correlations, factors analyses, and a variety of other programs. The Research Group in Traffic Studies at University College London (England) uses the OSIRIS system to analyze traffic accidents. A major advantage of the system is the ease of computer operation particularly for those without much understanding. Even a very complicated set of tabulations can generally be prepared for running within a day, and a simple tabulation takes only minutes, significantly less time than that required for a special purpose program. OSIRIS is much more economical than special purpose programs, especially if the costs of developing the special purpose programs are considered. OSIRIS has a significant advantage in that it can be used for a wide range of data, including not only any kind of accident data, but also flow data, origin and destination data, questionnaire data results, and any other kind of data with a set pattern of information given for a number of cases. Some programming format and set-up and codebook information is appended.

by Nicola Skelton

University Coll. London, Res. Gp. in Traffic Studies, England

Publ: HS-017 695 (PTRC/P/84), Accident Analysis, London, 1973

Rept. No. J15; 1973; 19p

Supported by the Science Res. Council. Presented at the P.T.R.C. Seminar at the Univ. of Sussex, England, 27-29 Jun 1973.

Availability: In HS-017 695

HS-017 700

EXPERIMENTAL RESEARCH CONCERNING THE EFFECTS OF POLICE ENFORCEMENT ON TRAFFIC ACCIDENTS

The methods and results of an experiment conducted in Denmark concerned with the effects of police enforcement on traffic accidents are discussed. Enforcement is described as highway patrolling only for the purposes of this research. The experimental design involved allocating a force of 25 policemen to patrol the experimental road (about 75 kilometers) and comparing the accident rates and behavioral observations made on this experimental road and a set of control roads. Lit-

tle or no change of speeds was observed on the experimental roads. In general, the traffic observations (of gap acceptance at intersections, overtakings, and speed) show a picture of slight but uncertain changes in certain specific aspects of traffic behavior, although the changes are not conclusive with respect to possible effects of the increased enforcement. Complete accident data are not yet available for the three year experimental period. Preliminary data indicate that the enforcement, defined as the average number of patrols on the highway, was too small to make any significant impression on drivers. Interviews with motorists indicated that the average number of patrols noticed during the experiment was less than four. Behavioral data shows only marginal changes, if any. It appears that if an enforcement effort is to have any measurable influence on driver behavior and traffic accidents, the density of patrols should be higher than one patrol per 20 kilometers of highway. However, the effect of such a density on traffic accidents cannot be determined from this study. A map of Denmark, showing experimental and control roads, and a comparison of personal injury accident rates on both types of roads (1962-1970) are appended.

by N. O. Jorgenson

Danish Council of Road Safety Res., 1, Anker Englundvej, DK-2800 Lyngby, Denmark

Publ: HS-017 695 (PTRC/P/84), Accident Analysis, London, 1973

Rept. No. J16; 1973; 10p

Presented at the P.T.R.C. Seminar held at the Univ. of Sussex, England, 27-29 Jun 1973.

Availability: In HS-017 695

HS-017 701

SELECTION OF ACCIDENT BLACK-SPOTS ON HIGHWAYS IN DENMARK THROUGH THE YEARS 1967-1971

The approximately 40,000 traffic accidents which occurred in Denmark during the period 1967 through 1971 are being analyzed in order to make a list of assumed black spots, which will be used to assist the road administration in giving priority to accident prevention measures. In addition, accident data will be examined to determine whether certain road classes are significantly more dangerous than the average road. The model for identifying black spots includes: listing road sections according to the size of the accident density; listing the road sections according to the size of the accident rate; and analyzing the relationship between traffic volume and number of accidents. The model for identifying injury black spots includes: listing road sections according to the size of the injury density; listing road sections according to the size of the injury rate; and analyzing the relationship between the number of injuries on a particular road section and the total number of injuries for the whole country per road class per year. Data collection included the recording of information about roads, traffic data, and accident data. A complete list of all road sections, with data which can be used to decide whether a particular road section is an accident black spot and/or an injury black spot, was prepared. The final results of the system are not yet available.

by Kjeld Petersen

Laboratory of Road Data Processing, Copenhagen, Denmark

Publ: HS-017 695 (PTRC/P/84), Accident Analysis, London, 1973

Rept. No. J17; 1973; 20p 4refs

Presented at the P.T.R.C. Seminar held at the Univ. of Sussex, England, 27-29 Jun 1973.

Availability: In HS-017 695

March 31, 1976

HS-017 704

HS-017 702

ACCIDENT DATA SYSTEMS AND REMEDIAL WORK ORGANISATION %ORGANIZATION%

An analysis of 24 reports received from counties and major cities in England shows that no two use precisely the same system for processing data related to traffic accidents and that there is, in some cases, a marked difference of philosophy in their approach to remedial action. In collecting traffic accident data, it is necessary to select that detail which is common to a great many accidents and which is also useful for the purpose of determining remedial action. Each police force is required to report certain selected data with respect to all personal injury accidents to the British Department of the Environment. The coding of selected accident data will depend on the method of storage used. Visual presentations of accident concentrations may take the form of manual plotting, computer print-outs in the form of histograms (related to a base line derived from road meterage or grid references), and/or automatic data processing methods which alert the user of the system to specific local problems. In the last case, accidents related to the specific problem are then plotted manually. The majority of the counties and major cities who contributed reports on their accident data recording and processing systems store their selected data in a computer, usually one operated by the Treasurer's Department. The most common criterion used for ranking purposes is absolute accident totals. A substantial group favors the use of accident rates instead of accident totals, however. In those cases where the precise problem and its remedy are not clearly apparent from a preliminary study of the selected accident data retrieved from the information store, together with a systematic site survey, it is necessary to conduct an investigation in greater depth. Many authorities have already established specialist accident investigation and prevention units.

by W. G. Jehan
Department of the Environment, Road Safety (Local) Div., 12
Tothill St., London SW1, England
Publ: HS-017 695 (PTRC/P/84), Accident Analysis, London,
1973
Rept. No. J19 : 1973 : 9p
Presented at the P.T.R.C. Seminar held at the Univ. of Sussex,
England, 27-29 Jun 1973.
Availability: In HS-017 695

HS-017 703

GLOUCESTERSHIRE COUNTY COUNCIL, COUNTY SURVEYOR'S DEPARTMENT, ACCIDENT RECORDING AND ANALYSIS

The accident recording and analysis system used by the County Surveyor's Department of the Gloucestershire County (England) Council is described. The department uses the STATS 19 as the basic input document. The police send the STATS 19 directly to the British Department of the Environment for their processing. The Department of the Environment then returns the original STATS forms to the County Surveyor's Department, which forwards them to the County Treasurer for punching and processing. The forms are retained for a period of 6 years to permit before and after studies. The police have agreed to provide additional information on the STATS 19 forms in order to allow better identification and description of the accident or site conditions. Proposals stemming from accident investigation take into consideration police action, education, and road improvement or alteration.

Black spots are investigated in detail. Study of the accident summaries and a site visit frequently disclose the areas for improvement. The County Road Safety Officer is responsible jointly with the police for road safety education in schools, clubs, and old peoples' homes. Traffic accident prevention is seen as a joint exercise involving several departments of the County Council. The establishment of a comprehensive accident recording analysis system is a pre-requisite to this approach and has proved most effective, there being constant demands for the information it can provide. An example of an accident record card and of an individual accident record are appended.

by N. F. Adnitt
Gloucestershire County Council, England
Publ: HS-017 695 (PTRC/P/84), Accident Analysis, London,
1973
Rept. No. J20-21(1) : 1973 : 8p
Presented at the P.T.R.C. Seminar held at the Univ. of Sussex,
England, 27-29 Jun 1973.
Availability: In HS-017 695

HS-017 704

CORNWALL COUNTY COUNCIL'S TRAFFIC ACCIDENT ANALYSIS SYSTEM

The traffic accident analysis system used by the Cornwall County (England) Council is described. The computerized system provides the police authority with regular monthly and cumulative totals of accidents and casualties analyzed by type of accident and cause. The data is supplied for each division, each district, and for the area as a whole. In addition, the numbers of accidents in each five mile length of the main roads in Devon and Cornwall counties are tabulated. Details of accidents of specific types are provided on request. The new system will: provide monthly tabulations of all reported accidents, with particular reference to those involving pedestrians or alleged road defects, occurring within each highway division in Cornwall; provide similar data on the basis of local authority areas in Devon; provide 6-year spatial records of all lengths of road in histogram form; provide calculated accident rates on lengths of road in terms of vehicle usage on the basis of a regular scan of the road network; and provide on demand, via a teletype terminal, the full details of specific accidents on specific lengths of road. A new method of referencing the road networks of both Devon and Cornwall has been devised in which all trunk and class one, two, and three roads have been marked off in kilometers and 0.1 kilometers, each road having zero kilometerage at its origin. In addition, digital road length sections codes have been introduced. The system, which is to be totally disc resident, requires three system data files: the histogramfile, which is a formatted file containing condensed data concerning each reported road accident arranged in road classification order and subsorted by kilometerage order; the dictiofile, which contains the data necessary to define the road networks of each county; and the currentfile, which contains the most recent 3 months' accident data sorted by month into road classification order and subsorted by kilometerage order. For the purposes of accident analysis, a constant unit equal to one million vehicle kilometers is used in determining the accident rate.

by R. H. Pitts
Cornwall County Council, Truro, England
Publ: HS-017 695 (PTRC/P/84), Accident Analysis, London,
1973
Rept. No. J20-21(2); 1973; 9p
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England, 27-29 Jun 1973.
Availability: In HS-017 695

HS-017 705

OBSERVATIONS ON ACCIDENT PLOTTING AND ANALYSIS

The West Yorkshire Police and Road Safety Unit (RSU) at Dewsbury, England, provides an excellent service on accident reporting and records and on the provision of accident data. The RSU in Dewsbury currently maintains a plot of accidents related to a street index, by which a visual presentation of accident locations over the last 6 years is immediately available. The West Yorkshire Police can now provide monthly, quarterly, and annual returns quickly and cheaply using a punched card record system. Under current local government reorganization, however, the present West Riding County will form a part of seven new counties. Since a complete computer based system solely for traffic accidents could be superseded in the near future by a management information system, consideration is being given to the possibility of improving the present system without great cost or effort in order to give sufficient detailed data for accident prevention for the immediate period and for some time in the future. One possibility is the production of a computer based plot of accidents based on the 8 figure grid reference entered by the police on their punched card. It is recommended that: the police continue to use their present punched card sorting methods; the future county RSU be prepared to take over the RSU's manual plots if the need arises and use the police cards and the graph plotter to carry out county wide factor analysis with a view to recommending allocation of maintenance funds for remedial measures; and the need for a broader computer based system be reviewed regularly.

by V. Cliffe; P. Mason
West Riding County Council, Planning Traffic and Safety
Sec., England
Publ: HS-017 695 (PTRC/P/84), Accident Analysis, London,
1973
Rept. No. J20-21(3); 1973; 6p
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England, 27-29 Jun 1973.
Availability: In HS-017 695

HS-017 706

THE USE OF ACCIDENT ANALYSIS IN IMPROVING VEHICLE DESIGN TO PREVENT ACCIDENTS

The use of accident analysis in improving vehicle design to prevent accidents is discussed. The sort of accidents that are likely to depend on vehicle handling, and the manner in which a car's behavior might contribute to causing these accidents were investigated. The following conclusions resulted from a study of data (for 1643 accidents) collected from accident forms supplied to car owners with the purchase of a Britax seat belt or a car fitted with Britax belts (and returned to Britax Seat Belts, Ltd., in the case of an accident): almost all loss of control and overturning occurs in single vehicle accidents; 32% of all accidents are single vehicle accidents; 70%

of the single vehicle accidents occur in rural areas; single vehicle accidents show a slight increase in frequency in adverse weather or lighting conditions; cars are most likely to overturn as the result of an abrupt change in ground contour; if a car collides with a substantial obstruction, its likelihood of overturning is very much reduced; over 60% of the single vehicle accidents involved skidding; overturning as a result of skidding was more likely in dry or icy road conditions than in wet conditions; 35% of the vehicles left the road at a bend and 60% left the road with rotation or deviation; the proportion of single vehicle accidents involving overturning occurring with only a driver present is significantly higher than that for all other accidents; rear engineered cars are more susceptible to loss of control and overturning than either the front wheel drive or conventional cars; the conventional car appears to be the least likely to lose control and the front wheel drive car seems to be the least likely to overturn; and 8.0% of the loss of control accidents involved tire failure. The statistics upon which the above conclusions are based are appended.

by I. S. Jones
University Coll. London, Res. Group in Traffic Studies,
England
Publ: HS-017 695 (PTRC/P/84), Accident Analysis, London,
1973
Rept. No. J26; 1973; 14p 4refs
Supported by the Science Res. Council. Presented at the
P.T.R.C. Seminar held at the Univ. of Sussex, England, 27-29
Jun 1973.
Availability: In HS-017 695

HS-017 707

OVERTURNING IN SINGLE VEHICLE ACCIDENTS

The manner in which the stability characteristics of different models of cars contribute to their likelihood of having an accident involving overturning was investigated. Accident analysis shows that 83% of accidents involving overturning are single vehicle and that in over half of these accidents the vehicle struck a curb or similar low fixed obstacle. A simple mathematical model has been developed to analyze overturning as the result of a curb impact. Equations for use in the model are included. In certain circumstances, cars can overturn if they spin on a level surface without striking any object. Overturning by sliding is likely to be due to the combined effect of many vehicle design features and of chance circumstances, rather than to one or two major features. Designing vehicles with a low ratio of height of the center of gravity to track is probably the most effective way of preventing cars from overturning. The following conclusions were reached: providing suitable measures can be found to describe them, the stability characteristics of particular models of car can be correlated with the proportion of cases in which those models overturn in single vehicle accidents; the calculated velocity required to overturn against a curb and the ratio of height of center of gravity to track both measure the proneness to overturning for particular models of car; and the correlation between the calculated velocity required to overturn against a curb and the proportion of overturning in single vehicle accidents for particular models of car was stronger than that for the ratio of height of center of gravity to track.

by I. S. Jones
University Coll. London, Res. Group in Traffic Studies,
England
Publ: HS-017 695 (PTRC/P/84), Accident Analysis, London,
1973
Rept. No. J27 : 1973 : 16p 3refs
Supported by the Science Res. Council. Presented at the
P.T.R.C. Seminar held at the Univ. of Sussex, England, 27-29
Jan 1973.
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HS-017 708

THE ROLE OF ALCOHOL AND OTHER DRUGS IN TRAFFIC ACCIDENTS

The role of alcohol and other drugs in traffic accidents was investigated. The increase in legislation on alcohol and highway safety has led to the development of such methods of measuring alcohol levels in breath and blood as the Breathalyzer, the Gas Chromatograph Intoximeter, and the Alcotest. The installation of such ignition interlock devices as the Phystester in cars might be another method of reducing alcohol involvement in accidents. The three major classes of drugs which can affect driving performance are: prescriptive psychotropic drugs; hallucinogenic drugs; and narcotics. The introduction of the 1967 Road Safety Act in England produced a significant reduction in traffic accidents and in casualties, but there are indications that its initial effect has now declined. The adoption of further countermeasures against drinking drivers should be considered. Comparatively little is known about the role of other drugs in traffic accidents. Laboratory studies have suggested that many psychotropic drugs cause a significant deterioration in driving-related skills, and that this deterioration is potentiated by moderate levels of alcohol. The interaction of cannabis and driving is not considered to be a serious problem at this time, and the use of narcotics still remains on a relatively small scale.

by A. B. Clayton
University of Birmingham, Dept. of Transportation and
Environmental Planning, England
Publ: HS-017 695 (PTRC/P/84), Accident Analysis, London,
1973
Rept. No. J28 : 1973 : 11p 26refs
Presented at the P.T.R.C. Seminar held at the Univ. of Sussex,
England, 27-29 Jan 1973.
Availability: In HS-017 695

HS-017 709

ROAD ACCIDENT REDUCTION FOR HIGHWAY ENGINEERS AND POLICE. PROCEEDINGS OF THE SEMINAR HELD DURING THE PTRC SUMMER ANNUAL MEETING, 8-12 JULY 1974, UNIVERSITY OF WARWICK [ENGLAND]

Methods by which highway engineers and police can reduce road accidents are examined. Leaflets on the following topics are presented: on-the-spot accident investigation; road/environment factors in accidents; and vehicle defects and their contribution to traffic accidents. Also presented are discussions of the following major topics: the valuation of life in the context of traffic safety (an examination of cost-benefit analysis); an evaluation of certain major publicity campaigns promoting traffic safety, particularly the use of seat belts; road surface reflectivity and night-time visibility; the safety and performance aspects of automobile tire design; vehicle

safety for the crash situation; an instrument which measures driver skill by monitoring vehicle acceleration, deceleration, and cornering; police traffic law enforcement aids; and methods of police traffic resource allocation.

Planning and Transport Res. and Computation (International)
Co., Ltd., 167 Oxford St., London W.1., England
Rept. No. PTRC/P/104 : 1974 : 168p refs
On cover: "Road Accident Reduction. Proceedings of Seminar
R, Summer Annual Meeting, Univ. of Warwick, July 1974."
Includes HS-017 710--HS-017 718.
Availability: Corporate author

HS-017 710

ON-THE-SPOT ACCIDENT INVESTIGATION: ROAD/ENVIRONMENT FACTORS IN ACCIDENTS; [AND] VEHICLE DEFECTS AND THEIR CONTRIBUTION TO ROAD ACCIDENTS

The results of 2,130 on-the-spot investigations conducted from March 1970-February 1974 show that the road user is the sole contributor in 50% of all accidents and that road and environment and vehicle factors are usually linked with a human factor. Statistics are given on various subdivisions of driver error, pedestrian error, and driver impairment. Investigation results showed that 549 road and environmental features were judged to be contributory in 366 out of 1,141 accidents. Aspects of road/environment factors mentioned include: poor layout; inadequate road markings and lighting, or confusing signs and markings; bad weather conditions, glare, poor maintenance, and fast traffic; and animals, construction, or parked vehicles in the road. Road and environmental factors are relatively easy to identify and can often be alleviated fairly quickly with low cost remedies. Accident prevention measures of an engineering nature can have a big impact on accidents. Vehicle factors such as design faults and vehicle defects were found to be contributory factors in 16 percent of the accidents investigated. Vehicle defects mentioned are tire pressure and tread, brakes, steering, and lighting. These are tabulated with the number of accidents to which they contributed, and specified by type of vehicle.

Transport and Road Res. Lab., Crowthorne, Berks. RG11
6AU, England
Publ: HS-017 709 (PTRC/P/104), Road Accident, London, 1974
p1-6
Rept. No. TRRL-LF-392; TRRL-LF-387; TRRL-LF-374 : 1974 : 3refs
Presented at the PTRC Seminar held at the Univ. of Warwick,
England, 8-12 Jul 1974.
Availability: In HS-017 709

HS-017 711

THE VALUE OF LIFE IN THE CONTEXT OF ROAD SAFETY

The use of cost-benefit analysis in decision making with regard to safety is examined. It is necessary to determine whether or not the costs involved in implementing a particular project are justified in terms of the benefits obtained by way of reduction in death, injury, and damage in order to decide how much of available resources should be devoted to traffic safety and how to allocate resources available for traffic safety. The use of a methodology for valuation of reduction in risk of death offers several advantages over the use of a methodology for a valuation of life: it is not an imposed valuation method, but at-

tempts to reflect the views of individuals in the society; it seems to be a more comprehensive approach and avoids the problem of valuing life itself; and it permits consideration for such factors as the relative fear of death in traffic accidents to death from other causes or of the willingness to pay more for a given risk reduction when the existing risk is high than when it is low. Used with care, cost benefit analysis can be a useful aid to decision makers in traffic safety. Given time, there are grounds for believing that the methods of valuation of traffic safety benefits will be improved, thus increasing the usefulness and acceptability of cost benefit analysis in traffic safety policy making.

by G. H. Mooney

University of Aberdeen, Dept. of Community Medicine,
Scotland

Publ: HS-017 709 (PTRC/P/104), Road Accident Reduction for
Highway Engineers and Police, London, 1974 p7-15
1974 ; 6refs

Presented at the PTRC Seminar held at the Univ. of Warwick,
England, 8-12 Jul 1974.

Availability: In HS-017 709

HS-017 712

THE APPLICATION OF RESEARCH IN THE PLANNING AND EVALUATION OF ROAD SAFETY PUBLICITY

A program of research studies was carried out on behalf of the United Kingdom Department of the Environment to evaluate the effectiveness of major publicity campaigns aimed at promoting road safety in general and the use of seat belts by motorists in particular. Although 85% of drivers thought that wearing seat belts would cut down the risk of injury in an accident when asked in a personal interview, observation studies showed that only 27% of drivers in 1968 and 17% of drivers in 1971 were wearing seat belts, although all of the cars were fitted with belts. The generally favorable disposition towards seat belts was not being translated into actual wearing. Advertising (television supported by press advertising and poster) was developed along four theme lines: statistical reasons for wearing seat belts when in a car; an appeal based on the idea that males were protecting their dependents by protecting themselves from potential injury; an attempt to instill an automatic habit of putting on the belts when entering a car and a regional attempt to encourage drivers and passengers in a particular locality to put forth a special effort to wear their seat belts. The advertising effort designed to stimulate automatic behavior was found to be most effective, while the regional approach was judged least successful. The observed level of wearing of seat belts doubled during the first three weeks of the campaign, but then stopped increasing. Results of an observational/interview study conducted at 16 road sites with an average of 6,750 observations and interviews per site per week indicate that there tends to be a discernible decrease in seat belt wearing which occurs almost as soon as television advertising stops, although the degree of fall-off appears to depend on the level of expenditure on such support media as posters which are visually co-ordinated with the television campaign. A "burst" pattern of television advertising was found to be more cost effective than a continuous campaign.

by G. E. Levens; E. Rodnight

Research Services, Ltd., London, England; Central Office of
Information, London, England
Publ: HS-017 709 (PTRC/P/104), Road Accident Reduction for
Highway Engineers and Police, London, 1974 p16-47
1974 ; 18refs

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for more Efficient Planning", ESOMAR/WAPOR Congress
1973, Budapest, 9-13 Sep 1973. Presented at the PTRC
Seminar held at the Univ. of Warwick, England, 8-12 Jul 1974.
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HS-017 713

ROAD SURFACE REFLECTIVITY AND NIGHT-TIME VISIBILITY

A survey of the knowledge and experience accrued in the areas of road surface reflectivity and night time visibility was conducted in order to: specify the desirable reflecting qualities so that the engineer knows what is wanted; examine the extra cost of lighting needed to make up for poor reflecting qualities so that this can be compared with the cost or other disadvantages of good surfaces; and consider how good reflecting qualities are best exploited, by more economical lighting or by using the same lighting and getting higher performance. Although a considerable amount of work has been done and general guidance is available on desirable reflection qualities and those of surfaces in use, systematic measurement and presentation of data is not yet available in Great Britain. The performance requirements of road lighting have been outlined in some detail, but more knowledge of wet weather requirements is needed. It is obvious that it is more difficult and expensive to meet the requirements on surfaces of poor reflectivity. Lighting needs to be clean and well adjusted to meet performance standards for modern traffic. There is no margin for reducing the cost of lighting or for producing higher performance unless specially lightened surfaces are used. These developments can, however, be expected in the future.

by G. K. Lambert

Thorn Lighting, Ltd., England; Univ. of Birmingham, England
Publ: HS-017 709 (PTRC/P/104), Road Accident Reduction for
Highway Engineers and Police, London, 1974 p59-78
1974 ; 25refs

Presented at the PTRC Seminar held at the Univ. of Warwick,
England, 8-12 Jul 1974.

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HS-017 714

SAFETY AND PERFORMANCE ASPECTS OF TYRE [TIRE] DESIGN AND THEIR INFLUENCE ON ROAD SAFETY

The performance requirements of tires are reviewed and the range of technologies involved in tire development are examined. Treatment of areas of recurring accidents with a skid resistant material has indicated that the road surface plays a major role in reducing wet skidding accidents. Injury accidents due to road wetness may be reduced by between 60% and 80%. Tire design alone cannot produce an adequate level of wet friction without the aid of suitable road surface textural characteristics. The efficiency of a new tire designed to remove normal amounts of water on road surfaces falls with wear. The need for a proper understanding of the required geometry of the macrotexture of the road surface is stressed. Tests now in use in Great Britain to determine the texture

depth of the road surface should be reconsidered and the use of an outflow meter is recommended. The Delugrip tire tread pattern is designed to remove bulk water from the road surface in the shortest possible time, creating a visibility problem due to spray. It is far more efficient for the bulk water to be removed preferably prior to the arrival of the tire through efficient drainage either horizontally or vertically, or at least the macrotexture geometry should encourage the outflow of water from under the contact patch, rather than the water being collected within the tread pattern elements. Where the road surface possesses an inadequate level of microtexture, all polymer compounds fail to develop an adequate level of wet friction. There is a need for a wearing course material of a superior skidding resistance for use on roads carrying a high traffic density. While skidding may not be the initial cause of multi-vehicle accidents on such routes, the number of vehicles involved and the severity of impact will depend on tire to road friction. The proposed standards for wet skidding resistance should be related to not only the site condition and accident record, but also to traffic density and average traffic speed.

by A. R. Williams
Dunlop Ltd., England
Publ: HS-017 709 (PTRC/P/104), Road Accident Reduction for Highway Engineers and Police, London, 1974 p79-100
1974; 13refs
Presented at the PTRC Seminar held at the Univ. of Warwick, England, 8-12 Jul 1974.
Availability: In HS-017 709

HS-017 715

THE CRASH PHASE OF VEHICLE SAFETY

The crash phase of vehicle safety and its relationship to effective seat belt usage are investigated. Results of a 1972 English survey indicate that seat belt wear rates vary from 12% in urban areas to 44% on the open highway. The wear rate for inertia reel belts was found to be almost double that for static belts. The effect of 90% car occupant seat belt usage on 1973 fatality figures for Great Britain would reduce the car occupant deaths from 3,046 to 1,371. Such a change would result in other aspects of the accident problem becoming relatively more important, since the percentage of total fatalities for car occupants would drop from 41.1% to 23.9% and that for pedestrian deaths would rise from 37.9% to 49.0%. Seat belt usage rates are given for a number of variables: seat occupation, sex, car make and year of registration, and type of belt. Pedestrian problems present an area of research which requires much more attention than it receives at present. Crash performance is a most important dimension of the road accident problem. Seat belt usage has been shown to be one of the most important factors in the whole spectrum of injury prevention measures.

by G. M. MacKay
University of Birmingham, England
Publ: HS-017 709 (PTRC/P/104), Road Accident Reduction for Highway Engineers and Police, London, 1974 p101-13
1974; 21refs
Presented at the PTRC Seminar held at the Univ. of Warwick, England, 8-12 Jul 1974.
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HS-017 716

TOWARDS A METHOD OF DEVELOPING DRIVER SKILL

An instrument has been developed which monitors the horizontal force on the vehicle arising from acceleration, deceleration, and cornering in order to provide performance information to the driver which can be utilized in developing improved driving habits and skills. This instrument is technically simple and consists of a pre-set speed-variable, omnidirectional gravity switch which registers the occurrence and duration of excessive G-levels. These incidents are brought to the driver's attention by an audible signal or by the clicking of a digital counter meter which accumulates the score for each journey. Extensive testing (10,000 miles) showed that: the measure is acceptable to drivers and passengers both in the short and long term; the instrument is reliable and does not wear; the instrument is sensitive to setting angle, but is fairly stable over a period of months; the variations in instrument performance are less than the relative crudities of normal driving; and the instrument, when described, is seen as threatening by drivers, although it is more reassuring when used. Problems with the instrument include: it does not compensate for road camber, road gradient, or vehicle roll; it may create errors due to prevailing wind; it does not operate sensitively enough on ice; and it could encourage a false sense of security in drivers by making them think that they are driving safely if the instrument is not operating. This approach to developing the skills of existing drivers has the following advantages: it provides the driver with objective information about crucial parameters of vehicle and driving safety; it builds the driver's self-esteem and wish to develop skill; and it recognizes the efficacy of the manufacturers' appeal to drivers' strengths, meeting the drivers' need for both physical feedback of a useful nature and psychological support for enhancing driving skills.

by A. J. Eccles; B. Shorthouse
Manchester Business School, England; Open Univ., England
Publ: HS-017 709 (PTRC/P/104), Road Accident Reduction for Highway Engineers and Police, London, 1974 p114-27
1974; 3refs
Presented at the PTRC Seminar held at the Univ. of Warwick, England, 8-12 Jul 1974.
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HS-017 717

AIDS TO POLICE IN TRAFFIC LAW ENFORCEMENT

Aids to police in traffic law enforcement are examined. The police aim in relation to traffic and legal and manpower factors affecting enforcement are discussed. Aids to enforcement against excessive vehicle speed, excessive noise, excessive weight, bad tires, and drunken driving are considered. Also discussed are certain non-technical devices which aid in enforcement, known as "sleeping policemen": roadway striping, unevenness of road surface, roadway humps, and physical narrowing of roadway. Photography and accident investigation operations are considered as indirect aids to traffic law enforcement. Certain recommendations regarding the future management of traffic are made.

by J. A. Dellow
Metropolitan Police, London, England
Publ: HS-017 709 (PTRC/P/104), Road Accident Reduction for
Highway Engineers and Police, London, 1974 p128-40
1974

Presented at the PTRC Seminar held at the Univ. of Warwick,
England, 8-12 Jul 1974.
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HS-017 718

THE DEPLOYMENT OF POLICE TRAFFIC RESOURCES

Methods of allocating the resources of a police traffic division are examined. The aim of the research was to improve the effectiveness of the traffic police by the formulation of a resource allocation system based on study of the interaction of the police, the road user, and the traffic environment. The requirements for a resource allocation system are: police operational objectives; a means of estimating the frequency of occurrence of situations affecting these objectives; a means of predicting the effect of using various police resources in controlling these situations; data on the environment necessary to the assessment of the states of resources; and scheduling and allocation procedures and systems which can produce feasible allocations to meet these objectives. In order for traffic police to reduce the frequency, severity, and after effects of road accidents, police must develop a methodology for identifying the potential accident situations and their environment and know how the traffic police can influence driver behavior and measure the effect on reducing the conflict/accident risk level. Methods available for predicting the accident risk of a given site include: compilation of the accident histories of the site; examination of the relationships between risk and variables describing the environment at the site; and a combination of these two approaches. Assessments of the effect of police tactics, made both in the past and on a continuing basis, provide a prediction of the effect of a particular resource usage. Using the accident and resource usage data, the available resources can be matched to the assessment of the state of the environment by allocation algorithms.

by B. Luetchford; P. J. Thurbin
Home Office, Police Scientific Devel. Branch, England,
Plessey Co., Ltd., Systems Res. and Planning Unit, England
Publ: HS-017 709 (PTRC/P/104), Road Accident Reduction for
Highway Engineers and Police, London, 1974 p141-64

Presented at the PTRC Seminar held at the Univ. of Warwick,
England, 8-12 Jul 1974.
Availability: In HS-017 709

HS-017 719

DYNAMIC TESTS OF A YIELDING SEAT AND SEAT BELT SYSTEM FOR CRASH PROTECTION

Dynamic tests were carried out on standard and yielding seat belt restraint systems to evaluate and compare their performance. The standard system was of the 3-point type with the seat belts attached to the seat. The yielding system had energy absorbers in the shoulder strap and seat anchorage. Test sled accelerations ranged from 120 to 240 meters per second squared with the standard system and to 300 meters per second squared with the yielding system. Peak restraint loads increased progressively with increase in acceleration in

the case of the standard system, but the yielding system allowed an increase in the acceleration of about 85% without an increase in peak load. At a sled acceleration of 240 meters per second squared the load in the straps of the yielding system was 70% of that in the standard system and, in the seat, 50% of that in the standard system. These improvements were achieved by an increase in movement at the shoulder of 80 millimeters and an increase at the hip of 35 millimeters.

by S. R. Sarraülhe; N. D. Hearn
Dept. of Defence, Aeronautical Res. Labs., P.O. Box 4331,
Melbourne, Vic. 3001, Australia
Rept. No. ARL/Struc.-358; 1975; 43p 9refs
Availability: Corporate author

HS-017 720

THE VARIATION IN THICKNESS OF TOUGHENED GLASS FROM CAR WINDOWS

The thickness of toughened safety glass in a large number of cars (a total of 110 British Leyland, Ford, General Motors, Chrysler, and assorted automobiles from various countries) has been measured. Micrometer screw gauges were used to measure the thickness of the windshield, side window, and vent window glass. The thickness of toughened safety glass is shown to be a more effective means of discriminating between samples of safety glass than refractive index or density measurements. Histograms describing the various distributions of thickness for windscreen (102), side window (435), and vent window (205) populations are presented.

by G. D. Renshaw; P. D. B. Clarke
Publ: Journal of the Forensic Science Society v14 n311 p311-17 (1974)
1974; 3refs
Availability: See publication

HS-017 721

COST-EFFECTIVENESS ANALYSIS OF ROADSIDE SAFETY IMPROVEMENTS

An implementable procedure for evaluating safety improvements along controlled- and non-controlled-access rural highways using a general computerized analysis model is described. A cost-effectiveness model provides the basic technique for comparing recommended safety improvements. The three functions of the implementation procedure are explained: conducting a detailed highway inventory to locate and define each road-side hazard; recommending feasible safety improvement alternatives for each hazard or group of hazards; and evaluating the recommended alternatives using the computer model. A hazard inventory form on which to record information regarding existing hazards and a hazard improvement form on which to record suggested improvements are illustrated. Each phase of the total procedure is discussed including: composition of inventory team; methods to locate existing hazards; details of the data forms; operation of the computer analysis model; and interpretation of the analysis results. Also included are case examples illustrating typical analysis results.

by Graeme D. Weaver; Donald L. Woods; Edward R. Post
Publ: Transportation Research Record n543 p1-15 (1975)
1975; 4refs
Sponsored by the Com. on Traffic Records.
Availability: See publication

HS-017 722

IDENTIFICATION OF HAZARDOUS RURAL HIGHWAY LOCATIONS

An effective procedure for identifying hazardous rural highway locations based on accident statistics is described. Indicators of accident experience that are necessary include: number of fatal accidents; total number of accidents; number of equivalent property-damage-only accidents; the nature of local safety improvement programs, and local traffic and roadway conditions; and the prevailing attitudes toward highway safety. Specific recommendations for the use of the procedure in Kentucky are given. Quality control procedures are used to establish critical accident rates. It is concluded that: in the identification of hazardous highway locations, distinction is made between short highway segments (spots) and large segments (sections); spots are further classified as intersection and non-intersection locations; intersection spots should include a distance of 0.15 mile along all approaches; non-intersection spots should be 0.3 mile floating segments; sections should be 3-mile floating segments; both spots and sections should be classified by highway type and location; and the use of one- and two-year intervals for accumulating and evaluating accident statistics is described.

by John A. Deacon; Robert C. Deen; Charles V. Zegeer
Publ: Transportation Research Record n543 p16-33 (1975)
1975 ; 19refs

Sponsored by Com. on Traffic Records.
Availability: See publication

HS-017 723

USE OF A QUASI-COORDINATE LINK-NODE SYSTEM FOR LOCATING ACCIDENTS

The development and use of a quasi-coordinate accident location system based on the U.S. Public Land Survey method for land subdivision is discussed. Developed in Iowa, this accident location and analysis system is a link-node system adapted to a quasi-coordinate method of accident location recording and used to accurately identify accident locations for computer system input. The methodology for applying the system to the complete network of urban and rural roadways in Iowa is discussed: selection of nodes (intersections, ramp terminals, railroad crossings, grade separation structures, bridges, road ends, 90° turns, and county boundaries) grade numbering system, and accident, location coding (coding with incomplete data, for complex intersections, urban areas, rural primary system, and rural secondary roads). Sample maps developed for use by accident coders are included. The system is highly user oriented to provide a wide range of summaries and analyses for highway and traffic engineers and law enforcement agencies.

by Merrell E. Goolsby; Frank C. Yu
Publ: Transportation Research Record n543 p34-43 (1975)
1975 ; 4refs

Publication sponsored by Com. on Traffic Records.
Availability: See publication

HS-017 724

ENGINEERING AND ADMINISTRATIVE CONSIDERATIONS IN CONSTRUCTING,

MAINTAINING, AND TESTING SKID-RESISTANT PAVEMENTS

Certain legal considerations, safety obligations, engineering concerns, and administrative problems are identified that must be addressed by the engineer-administrator in relation to constructing and maintaining pavements with adequate skid resistance properties and testing those skid properties. The monetary effect of claims against the state resulting from skidding accidents is considered. The engineer-administrator, in considering skid resistance, must be concerned with: testing for skid resistance; various design and construction problems involved in providing a skid-resistant pavement; and inability to attain or maintain skid resistance levels that are being advanced as recommended minimums in various publications. The engineer-administrator must also be concerned with the shortage of materials and the increased cost of importation, particularly in light of the energy crisis, and be aware of possible reductions in the frictional needs of traffic.

by William Gartner, Jr.
Publ: Transportation Research Record n523 p15-19 (1974)
1974 ; 4refs

Publication sponsored by Legal Resources Group Council and Group 2 Council.
Availability: See publication

HS-017 725

BACKGROUND AND DEVELOPMENT OF THE FEDERAL HIGHWAY ADMINISTRATION'S SKID-ACCIDENT REDUCTION PROGRAM

Federal Highway Administration (FHWA) actions related to the pavement skid-control qualities of Federal-aid highway projects since the Highway Safety Act of 1966 are reviewed. Emphasis has been on measuring skid resistance, obtaining and correlating accident data, material properties, and practices in design, construction and maintenance for better skid resistance, and determining priorities for current projects. The development of a coordinated research program, expanded in 1970 to include study on all phases of skidding accidents and the engineering factors and actions for their reduction, is discussed. Three field test centers for calibrating skid measurement equipment have been developed. The present FHWA program uses guidelines set by each state for their specific conditions to establish skid reduction priorities.

by D. W. Loutzenheiser
Publ: Transportation Research Record n523 p20-4 (1974)
1974 ; 1ref

Publication of this paper sponsored by Legal Resources Group Council and Group 2 Council.
Availability: See publication

HS-017 726

HUMAN HEAD AND NECK RESPONSE TO IMPACT ACCELERATION

Using instrumented human subjects, a study of human head and neck response to impact acceleration was conducted to: measure precisely the complete input acceleration to the head and neck measured at the first thoracic vertebra; measure precisely the dynamic response of the head and neck to the input acceleration; develop a method of obtaining the data in such a format that automatic data processing may be used ex-

tensively; and develop and validate a general method for the experimental measurement of the bioengineering characteristics of the human body with such precision, accuracy and repeatability that a mathematical model or other analog of the human dynamic response to impact acceleration can be constructed. The following procedures were adopted to achieve the stated goals: displacement was measured by double integration with respect to time of acceleration measured on the head and spine by accelerometers and rate gyros rigidly mounted on the male subject; a second and independent means of measuring displacement consisting of sled-mounted, pin-registered, high-speed, high-precision, 16 millimeter films; and data were collected in a format compatible with automatic processing by digital computer. Twelve volunteer subjects from the U.S. Army completed a total of 199 sled test runs with the following profiles: 3g through 10g at 250g's per second in 1g increments; 3g through 8g at 500g's per second in 1g increments; and 6g, 250g's per second, 10g, 250g's per second, and 6g, 500g's per second unencumbered. Subjects wore lap and shoulder belt restraints. It is concluded that: the response of the unrestrained human head and neck to negative g impact acceleration is two dimensional in the mid-sagittal plane, characteristic, and repeatable; simultaneous photographic and sensor measurement of the response is possible, permitting cross validation; adequate presentation of the response requires detailed plotting of the variables as time functions; and the utilization of the theoretical mechanics of rigid body motion is a valid experimental design basis for measuring the response of human head and neck to impact acceleration. Photographs are provided and graphs of all test runs are provided.

by Channing L. Ewing; Daniel J. Thomas
Naval Aerospace Medical Res. Lab.; Army Aeromedical Res. Lab.

Contract DOT-HS-187-2-295

Rept. No. NAMRL-Mono-21; USAARL-73-1 ; 1972 ; 386p
16refs

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Command, Navy Bureau of Medicine and Surgery, and Office
of Naval Res. Medical and Dental Div.
Availability: Naval Aerospace Medical Res. Lab., Naval
Aerospace and Regional Medical Center, Pensacola, Fla. 32512

HS-017 727

A REVIEW OF CASE LAW RELATING TO LIABILITY FOR SKIDDING ACCIDENTS

Highway departments now find themselves exposed to liability for accidents that result from what used to be considered purely weather-related causes. It is stated that a program of skid testing is imperative for early detection of low skid resistance areas on highways. Various case laws relating to liability for skidding accidents are reviewed. Solutions to problems of low skid resistance, such as grooving, are discussed. Generally, a public entity is not liable for a highway made slippery by rain alone; however, public entities may be held liable for hazardous low skid resistance conditions resulting from their own actions or inactions (worn pavements; defectively designed, slippery pavements, unplanted eroding cut-slopes, improperly applied seal coats, and clogged drains and drainage ditches that cause ponding). They also may be found liable when conditions are purely weather-created and the hazard is such that the public entity has a duty to remove it entirely or ameliorate it by the use of warning signs. The reasonableness of the public entity's actions generally will be the deciding factor on whether it will be held liable.

by Robert F. Carlson

Publ: Transportation Research Record n523 pl-14 (1974)
1974 ; 98refs

Publication of paper sponsored by Legal Resources Group
Council and Group 2 Council.
Availability: See publication

HS-017 728

BICYCLE ACCIDENTS AND USAGE AMONG ELEMENTARY SCHOOL CHILDREN IN THE UNITED STATES. FINAL REPORT

A study of a nationally representative sampling of 23,699 elementary school aged bicyclists from 120 schools, 80 cities, and 34 states is reported. Questionnaires, administered to elementary school aged students on a class basis, addressed the following variables: bicyclist's sex, age, height, weight, and riding experience; bicycle type, style, wheel size, brake and gear type, mode of assembly and repair, equipment, and condition; and bicycle use information from the most recent riding day including time, hours, and distance ridden, transporting of passengers and packages, traffic density, road and weather condition, and position on traffic way. The children filled out other information with the help of their parents regarding: the type and manner of any (significant) accidents in the past five years causing injury or bicycle damage, position of rider on bicycle, activity and speed prior to accident, familiarity with accident locale, and injury data (type, part of body affected, injury producing surface, and treatment required). The group averaged .48 significant accidents per year, an estimated annual mileage of 667 miles, and a rate of .72 accidents per 1,000 miles. It was also found that: male bicyclists reported 46% more accidents and 46% more mileage than females; the number of accidents, mileage, and accident rates per mile generally increased with age; accident rates per 1,000 miles were .81, .74, and .69 for the middleweight, high-rise, and lightweight bicycle models, respectively; 70% of the accidents within the past year occurred during spring and summer and 50% on the weekend; of the most serious injuries 70% were cuts and bruises, 11% were sprains and fractures; 6% were lacerations, 1% involved concussion, and 8% were categorized as other; and younger bicyclists with less experience reported more serious injuries.

by Thomas W. Chlapacka; Stuart A. Schupack; Thomas W. Planek; Nancy M. Klecka; Gerald J. Driessen
National Safety Council, 425 North Michigan Ave., Chicago,
Ill. 60611; Schwinn Bicycle Co., 1856 North Kostner Ave.,
Chicago, Ill. 60639
Rept. No. 1901-6; PB-242 527; NSC-RD-75-2 ; 1975 ; 145p
28refs

Supported in part by the Schwinn Bicycle Co.
Availability: NTIS

HS-017 729

CRASHWORTHINESS FOR HIGH-CAPACITY PERSONAL RAPID TRANSIT VEHICLES

Guidelines are developed for the design of high-capacity Personal Rapid Transit (PRT) vehicles in which the possibility of serious collision injury to occupants is minimized. The basic tradeoffs between alternate seating arrangements, passenger restraints, and shock absorbers are examined and various design alternatives are proposed and evaluated both qualitatively and quantitatively. Vehicles for high-capacity PRT are

envisioned as having a maximum capacity of three to six seated passengers and are assumed to be approximately the same size as typical compact automobiles. The limits of human tolerance to rapid deceleration are discussed and a qualitative evaluation of design elements such as interior configuration, passenger protective devices, and energy-absorbing bumpers is provided. Vehicle and occupant collision dynamics, the kinematics of an oblique collision, and the kinematics of front and rear collisions are examined and discussed. The results of a set of computer simulations of front and rear impacts between PRT vehicles and between PRT vehicles and a fixed barrier are also presented. It is concluded that: it is relatively simple to protect passengers at low impact velocities (17 mph) with a hard padded and crushable front structure; passenger protection in a barrier impact at medium speeds (34 mph) can be assured by the use of a substantial energy-absorbing front structure in addition to a well padded dash placed close to the passenger or an air bag; and passenger protection at high speed impacts (68 mph) is impossible to obtain with any reasonable combination of shock absorbers and passenger protective devices.

by W. L. Garrard; R. J. Caudill; T. R. Rushfeldt
University of Minnesota, School of Mechanical and Aerospace Engineering, Minneapolis, Minn. 55455
Rept. No. UMTA-MN-11-0037-74-1; PB-239 104 ; 1974 ; 127p
57refs
Sponsored by the Urban Mass Transportation Administration.
Availability: NTIS

HS-017 730

TRAFFIC ACCIDENT INVESTIGATION MANUAL

The accident investigation process involves collecting information, reporting, at-the-scene investigation, technical preparation, professional reconstruction, and cause analysis. Laws, standards, and administrative considerations which form the basis for traffic accident investigation are reviewed. Investigation of accidents requires organizational preparation, forms, training of investigators, and planning for investigation at the scene of the accident. The variety of information from and about people involved in the accident, the roads involved, and the vehicles involved are discussed and methods for obtaining this information are examined. Measurements, maps, and photographs play important roles in accident investigation and reconstruction. The objectives and fundamentals of accident reconstruction are described. Specific methods for use in reconstructing speeds, flips and vaults, collision placements, and time and position are discussed. Law enforcement activities connected with traffic accident investigations, which may include enforcement of traffic or other law violations related to the accident, investigation of specific offences, and case preparation for trials, are considered. Traffic accident investigators are also concerned with the determination of the causes and contributing factors related to the accident. Other associated activities which a traffic accident investigator may perform are also examined: handling emergencies; investigation of hit-and-run accidents; providing information concerning the accident; and testifying in court proceedings.

by J. Stannard Baker
Northwestern Univ., Traffic Inst., Evanston, Ill.
1975 ; 347p refs
Individual chapters are abstracted separately as: HS-017 731--HS-017 742. Previously published under the following titles: "Accident Investigation Manual", "Traffic Accident Investigator's Manual", and "Traffic Accident Investigator's Manual for Police."
Availability: Corporate author \$18.00

HS-017 731

THE INVESTIGATION PROCESS

The whole process of traffic accident investigation, especially technical levels or stages through which an investigation may be carried, is described. Traffic accident investigation is primarily a matter of obtaining, recording, refining, and interpreting information. The intended specific uses of the information about accidents should determine the amount and character of the information collected. Selected information about as many accidents as possible is needed for statistical tabulations, discovery of high accident locations, and evaluation of the effectiveness of safety efforts. Additional information about the individual accident will probably be needed if the accident is fatal or has other serious consequences. Special supplementary data may be collected for a limited time for research purposes. The process of accident investigation ranges from the collection of simple data to the interpretation of observations and inference about events and circumstances. Five levels of activity in accident investigation are: reporting; at-the-scene investigation; technical preparation, including delayed data collection and organization of data for study and interpretation; professional reconstruction; and cause analysis. An important part of the process of investigation is the examination and evaluation of bits of information as they are gathered, recorded, and reviewed to determine the quality of the information. Starting an investigation with some conscious or unconscious preconception may complicate the investigatory process.

by J. Stannard Baker
Northwestern Univ., Traffic Inst., Evanston, Ill.
Publ: HS-017 730, Traffic Accident Investigation Manual, Evanston, Ill., 1975 Chap. 1 p1-7
1975
Availability: In HS-017 730

HS-017 732

BASIS FOR TRAFFIC-ACCIDENT INVESTIGATION

The laws, standards, and administrative arrangements which provide the basis for traffic accident investigation, especially by police departments, are reviewed. Laws relating to the investigation of traffic accidents, generally including motor vehicle codes, municipal ordinances, and driver responsibilities, usually provide neither constraints nor guidance to the investigator or administrator. A national standard for classifying motor vehicle traffic accidents has been adopted, permitting the comparison of accident statistics from various sources. Classifications in the standard include: injury to persons; damage to vehicles, and descriptions of the vehicles. The nine classifications for the accident as a whole are: injury severity; damage severity; number of vehicles involved; first harmful event; roadway related location; class of road; junction related location; land use in the area; and the type of political subdivision. The National Highway Traffic Safety Administration standard on accident investigation and reporting requires owner and driver reports, police investigation, and the use of accident investigation teams representing such different interest areas as police, traffic, highway and automotive engineering, medical, behavioral, and social sciences. The principal basis for traffic accident investigation is administrative policy. Police duties connected with accidents may include: duties connected with the emergency; accident investigation; enforcing traffic and other laws related to the accident; maintaining files of accident reports; transmitting accident informa-

tion to other agencies; and making information obtained available to concerned individuals. Nonpolice investigations of traffic accidents include claim investigations and research investigations.

by J. Stannard Baker
Northwestern Univ., Traffic Inst., Evanston, Ill.
Publ: HS-017 730, Traffic Accident Investigation Manual,
Evanston, Ill., 1975 Chap. 2 p8-16
1975 ; 5refs
Availability: In HS-017 730

HS-017 733

PREPARATION FOR TRAFFIC-ACCIDENT INVESTIGATION

Preparation for traffic accident investigation includes: organizational preparation; development of forms for data collection; investigator preparation; and planning at-the-scene investigation. Organizational preparation includes: development of guides and manuals for investigators; delegation of responsibility for investigations; acquisition of the necessary equipment; and training and supervision of investigators. Traffic accident report forms should reflect the police department policies on data collection. A basic form used for recording routine data must be supplemented by additional information such as photographs and measurements in the case of severe accidents. About 80% of all accidents will require completion of only a simplified form which provides for the collection of: most data regularly tabulated; data accumulated for traffic engineering purposes; and information entered on driver records. Supplementary forms for use in cases of severe accidents may include: forms for the collection of descriptive data; forms for recording data frequently collected, such as body injuries and damage to vehicles; special instructions to investigators; and forms for the collection of special data for research purposes. Investigator preparation should include a combination of classroom discussion and field practice with good instructors. The stages of planning at-the-scene investigations are: on learning of the accident; on arrival at the scene of the accident; when the emergency is under control; when urgent data collection is complete; and when work at the scene is finished. Examples of traffic accident forms of varying complexities are provided.

by J. Stannard Baker
Northwestern Univ., Traffic Inst., Evanston, Ill.
Publ: HS-017 730, Traffic Accident Investigation Manual,
Evanston, Ill., 1975 Chap. 3 p17-28
1975 ; 12refs
Availability: In HS-017 730

HS-017 734

INFORMATION FROM AND ABOUT PEOPLE

Information must be collected from and about a variety of people involved in traffic accidents. The people involved may be classified as drivers, passengers, witnesses, or any other person who is acquainted with people or vehicles connected with the accident or knows some of the results or other circumstances of the accident. These people who have information about the accident must be found before they can be identified, described, or questioned. Adequate identification of people is usually provided for on accident report forms. The levels of inquiry into a traffic accident will depend on the circumstances and severity of the accident and may be designated as: identification and description only; at-the-scene

inquiry; detailed statements; testimony and depositions; and interrogation. Injuries must be classified and technical descriptions of the injuries may be required. The condition of the driver before the accident should be investigated in order to determine whether unfavorable driver conditions contributed to the accident. The main conditions which may temporarily impair the ability to drive are: alcohol; drugs and medicines; carbon monoxide; drowsiness and sleep; and sudden disablement. The more permanent conditions which establish a level of driver capability include: natural abilities; learned capabilities; and attitudes. Examples of completed traffic accident statement forms, an alcohol influence report form, flow charts of the operational phases of the road-vehicle-driver system and parts of the driver personality are provided.

by J. Stannard Baker
Northwestern Univ., Traffic Inst., Evanston, Ill.
Publ: HS-017 730, Traffic Accident Investigation Manual,
Evanston, Ill., 1975 Chap. 4 p29-59
1975 ; 10refs
Availability: In HS-017 730

HS-017 735

INFORMATION CONCERNING ROADS

Road information which should be collected following a traffic accident includes: identification of the particular location; description of the road or roads at that location; conditions existing just before the accident which might have a bearing on the accident, including traffic on the road, weather, and light; and the effect of the accident on the road. The precise location of the accident must be determined in order for other investigators to conduct additional observations or measurements at the site, if necessary, and in order for engineers to determine where inadequacies in the road, traffic control devices, and the environment may have contributed to the frequency or severity of accidents. Road classification data generally include the class of trafficway, the number of lanes, and the land use character. Information about existing conditions includes data on: visibility; glare; road surface conditions; and the condition of traffic control devices. The results of accidents on the road will include: the final positions of the vehicles and bodies; tiremarks; skidmarks; metal scars; damage to fixed objects; debris; and signs that the vehicle left the ground. Example photographs of significant road information regarding accidents are provided.

by J. Stannard Baker
Northwestern Univ., Traffic Inst., Evanston, Ill.
Publ: HS-017 730, Traffic Accident Investigation Manual,
Evanston, Ill., 1975 Chap. 5 p60-104
1975 ; 3refs
Availability: In HS-017 730

HS-017 736

INFORMATION CONCERNING THE VEHICLE

Information concerning vehicles involved in a traffic accident includes: identification of the particular vehicles which distinguishes them from all other similar vehicles; description for classification purposes; damage classification; examination of the vehicle at the scene of the accident; and additional technical examination of the vehicle for special purposes. Vehicle identification information, which includes the current registration number and the name and address of the owner, is used for accident reports and supplementary accident investigation.

Description of the vehicle for classification purposes should include: the size and general structure; the body style and appearance; and the user or service. Damage classification data should describe the amount of damage and the location of the damage on the vehicle. Vehicle data collected at the scene of the accident may include: vehicle identification; vehicle descriptions; damage descriptions; final position; contents of the vehicle; and matching of contact damage. Technical examinations are usually made after the vehicle has been removed from the scene of the accident. These examinations, conducted after most severe accidents, are generally made with specific problems already in mind. Such examinations may include: determination of contact and induced damage; investigation of the imprints of the object struck and rub-off surface material; determination of the direction of the thrust against each vehicle; examination of signs of ground contact; determination of the effect of the accident on the tires; examination of the effect of the accident on lamps; examination to determine the sources of injury to passengers; and determination of vehicle deficiencies.

by J. Stannard Baker
Northwestern Univ., Traffic Inst., Evanston, Ill.
Publ: HS-017 730, Traffic Accident Investigation Manual,
Evanston, Ill., 1975 Chap. 6 p105-28
1975 ; 18refs
Availability: In HS-017 730

HS-017 737

MEASUREMENTS AND MAPS

Fatal and other severe accidents may require measurements and maps which provide a variety of information about distances. Reconstruction of the accident for legal or other purposes often requires a map of the post accident situation and measurements of the road and the location of objects on it. Measurements used in traffic accident investigation include both urgent measurements at the scene to locate things which may disappear or be moved and additional measurements of the location to make scale maps. Items which should be located include: final vehicle positions; positions of dead or injured persons; gouges or scratches on the paving; tire marks; scars on the roadside connected with the accident; and objects on or near the road which were broken or marred as a result of the accident. Marks may be applied to the roadway to facilitate measurements and to help identify photographs. Measurements to locate results of traffic accidents must be made before the after-accident situation is disturbed and signs of what happened have begun to disappear. The person preparing maps must have at hand field notes of measurements to locate the results of the accident and field notes or maps of the site of the accident. Before starting to draw the map, the following decisions must be made: how much to include; what scale to use; the size of the map; is it a working or a display map; what measurements should be shown as numbers; and which direction is north. The accuracy with which measurements are recorded will be determined by the scale of the map to be produced, the detail necessary, and the ultimate use of the measurement. Examples of field notes and measurements for accidents at various stages of completion and illustrations of the various symbols useful for accident field sketches, diagrams, and maps are provided.

by J. Stannard Baker
Northwestern Univ., Traffic Inst., Evanston, Ill.
Publ: HS-017 730, Traffic Accident Investigation Manual,
Evanston, Ill., 1975 Chap. 7 p129-72
1975 ; 3refs
Availability: In HS-017 730

HS-017 738

PHOTOGRAPHY

Photography is an important means of recording certain kinds of information about traffic accidents. Photographs can provide a permanent, accurate, and unbiased record of things specifically observed by an investigator. They may also be used to capture the detailed appearance of something such as a mark on the road or damage to a vehicle, which may later reveal significant details not observed at the time the picture was made. As a record of observations, photographs can serve to recall later to an investigator's mind details of what was seen and to explain what the investigator saw to someone else. Photographs of traffic accidents may be made by police traffic accident investigators, professional photographers, free lance photographers, newspaper photographers, damage appraisers, claim adjusters, or amateur photographers. Things which may be photographed following a traffic accident include: results of the accident on the road, such as tire marks, ruts and furrows, or gouges; results of the accident on the vehicles, including contact and induced damage and details of the damage; matching surfaces where contact is believed to have occurred; and road situations, including view obstructions, general views, aerial pictures, and traffic control devices. A variety of technical problems may affect the accuracy of the photographs. Negatives and prints should be identified by a numbering system and a photo data sheet should be prepared to make notes about the picture. The techniques of taking photographs of a traffic accident under various lighting conditions and the equipment needed are described. Example photographs illustrating both good and bad information recording are provided.

by J. Stannard Baker
Northwestern Univ., Traffic Inst., Evanston, Ill.
Publ: HS-017 730, Traffic Accident Investigation Manual,
Evanston, Ill., 1975 Chap. 8 p173-200
1975 ; 6refs
Availability: In HS-017 730

HS-017 739

RECONSTRUCTION

The reconstruction of a traffic accident depends on the accuracy of data collected on the scene and subsequent to the accident. The objective of traffic accident reconstruction is to describe the events of the accident, including the position on the road, facing or heading direction, speed, direction of travel, acceleration or deceleration, and rotation of each vehicle or pedestrian involved. In addition, driving strategy and evasive tactics, traffic law violations, how injuries were received, and contributing factors to the cause of the accident may be determined through reconstruction. Limitations to the reconstruction process include: the quantity and quality of information available; the ability of the people doing the reconstruction; how much reconstruction is required; and the time and money available. An investigator must understand such fundamentals as velocity and speed, the center of mass and center of gravity, the drag factor, and the coefficient of friction.

tion in order to dependably estimate speeds. Estimating vehicle speeds from braking skidmarks was probably the earliest application of basic mechanics to traffic accident reconstruction. Accident reconstruction now may include: calculation of the speed to sideslip; determination of the speed indicated by a fall in the air; analysis of flips and vaults; and calculation of combined speeds. Another goal of reconstruction may be the determination of the position of the vehicles on the road at the time of collision. Reconstruction may also be used to determine whether one or both drivers could have avoided the accident. The calculations required for each stage of an accident reconstruction are fully described and charts of various speed, acceleration, and deceleration forces involved in an accident are provided.

by J. Stannard Baker
Northwestern Univ., Traffic Inst., Evanston, Ill.
Publ: HS-017 730, Traffic Accident Investigation Manual,
Evanston, Ill., 1975 Chap. 9 p201-57
1975 ; 10refs
Availability: In HS-017 730

HS-017 740*

ENFORCEMENT

One of the purposes of police investigation of traffic accidents is to obtain evidence that a traffic law has been violated. Departmental policy should be to take appropriate enforcement action whenever evidence of a law violation is discovered in connection with a traffic accident. In principle, enforcement action should be taken by an officer at the scene of a collision whenever there is sufficient evidence available to support such action. However, discovering satisfactory evidence of violation in connection with an accident is often difficult. At any time during the accident investigation process information collected may suggest that a law has been violated, altering the direction or scope of the investigation to develop additional evidence of the violation. Criminal investigation procedures may be initiated as the result of a traffic accident, such as a hit-and-run situation. The three kinds of offences which warrant arrest in connection with traffic accidents are: simple traffic law offences; complex traffic law offences; and non-vehicle offences. Physical evidence at the scene of the accident may indicate violation of such laws as stop sign violations, driving on the wrong side of the road, overloading, driving under the influence of alcohol or drugs, or reckless driving. Non-traffic offences such as the possession of narcotics may be discovered during the investigation of an accident. If there is any anticipation that a trial may arise from any circumstances connected with an accident, care should be taken to collect data which can be used to prove that a law violation occurred.

by J. Stannard Baker
Northwestern Univ., Traffic Inst., Evanston, Ill.
Publ: HS-017 730, Traffic Accident Investigation Manual,
Evanston, Ill., 1975 Chap. 10 p258-70
1975 ; 13refs
Availability: In HS-017 730

HS-017 741

CAUSES AND FACTORS

The causes of traffic accidents and factors contributing to the occurrence of the accident are examined. The cause of an accident will involve a combination of simultaneous and sequen-

tial factors which each contribute to the actual accident. Operational factors may indicate how the accident occurred. These operational, or sequential, factors contributing to cause are malfunctions in perception, decision, and/or performance in trip preparation, driving strategy, and/or evasive tactics performed by the road-vehicle-driver system. The simultaneous factors are conditions in the form of attributes of the road, vehicle, and driver modified permanently or temporarily which determine, at various operational phases, the success or failure of the functions performed. Cause analysis is the effort to determine why an accident occurred from the available information. Such analysis involves the determination of the complete combination of factors that caused the highway transportation system to malfunction at the time and place of the accident with resultant injury and damage. Even if all the facts can be determined, discovering the combination of factors after an accident is always difficult and often impossible.

by J. Stannard Baker
Northwestern Univ., Traffic Inst., Evanston, Ill.
Publ: HS-017 730, Traffic Accident Investigation Manual,
Evanston, Ill., 1975 Chap. 11 p271-86
1975 ; 3refs
Availability: In HS-017 730

HS-017 742

ASSOCIATED ACTIVITIES

Any traffic accident investigator may become involved in such activities associated with but not a part of the actual accident as emergencies, hit-and-run investigation, liability for damages, providing information, and testimony. Emergencies may involve fire, hazardous materials, pollution, electrical hazards, injured persons, deaths, traffic and crowd management, and theft and pilferage. The accident investigator is the key person in hit-and-run investigations, since this person generally first discovers or confirms that the accident involves evasion of responsibility. After taking care of any emergencies, the investigating officer's most important duty is to collect information. This information may be necessary in connection with civil liability lawsuits resulting from the accident. The accident investigator may have to summon emergency assistance, notify the coroner or medical examiner about persons dead at the scene, notify relatives about traffic accident fatalities, notify the vehicle owners, and/or notify public utilities, street and highway departments, and/or driver license authorities. A traffic accident investigator may be required to submit to questioning concerning information acquired about the accident. This questioning may take the form of inquests, depositions, and/or court appearances.

by J. Stannard Baker
Northwestern Univ., Traffic Inst., Evanston, Ill.
Publ: HS-017 730, Traffic Accident Investigation Manual,
Evanston, Ill., 1975 Chap. 12 p287-321
1975 ; 5refs
Availability: In HS-017 730

HS-017 743

PHYSICAL CHARACTERISTICS OF CHILDREN AS RELATED TO DEATH AND INJURY FOR

CONSUMER PRODUCT SAFETY DESIGN. FINAL REPORT

A total of 41 body measurements were taken on 4,027 infants and children representing the United States population from 2 weeks to 13 years old using specially modified anthropometers, calipers, and girth devices. The children were studied at schools, child care centers and nurseries, and child clinics. The measurement devices utilized a 10-turn potentiometer for electrical readout of length, and a miniature pressure transducer in the paddle blades of the anthropometers and calipers provided for standardizing measurements on soft tissue. Data was recorded automatically by a portable mini-computer system. Center of gravity in standing and sitting positions was also obtained. Other devices were used for obtaining finger diameters, hand clearance, and grip size dimensions. Data are presented in both tabular and graphical format giving the mean, standard deviation, 5th, 50th, and 95th percentiles and number of measurements for each age interval.

by Richard G. Snyder; Martha L. Spencer; Clyde L. Owings; Lawrence W. Schneider
University of Michigan, Hwy. Safety Res. Inst., Huron Pkwy.
at Baxter Rd., Ann Arbor, Mich. 48105
Contract FDA-72-70
Rept. No. UM-HSRI-BI-75-5; PB-242 221; 1975; 242p 91refts
Rept. for Apr 1972-Mar 1975. Sponsored by the Consumer
Product Safety Commission.
Availability: NTIS

HS-017 744

FACTS AND FIGURES ON MOTORCYCLE ACCIDENTS IN 1974

Motor accident statistics are examined and several accident countermeasures are suggested. While motorcycles, motor scooters, and motorized bicycles comprised 3.7% of all vehicle registrations in the U.S. in 1974, they were only 1.5% of the total vehicles involved in all motor vehicle accidents, but 5.6% of the vehicles involved in fatal accidents. The mileage death rate for motorcycle riders in 1974 is estimated at about 14 deaths per 100 million miles of motorcycle travel. The number of deaths of motorcycle riders has increased steadily over the past 6 years. A motorcyclist involved in an accident is much more likely to be injured or killed than a rider in a vehicle offering more protection. Injuries to motorcycle riders also tend to be more severe than those to riders in other types of vehicles. The most common type of motorcycle accident is collision with another motor vehicle. Motorcycle accidents occur most frequently between 4 p.m. and 6 p.m. The worst day of the week for motorcycle accidents is Saturday. Most of the motorcycle operators involved in accidents are male and under 25 years of age. Many states have collected specific information on the presence of passengers, age, sex, and experience of motorcyclists involved in accidents. The lack of skill and training appears to be an important factor in motorcycle accidents. State legislation can have a significant effect on motorcycle fatalities, particularly legislation regarding the wearing of helmets, use of headlights at all times, and special licenses for motorcycle operators. Motorcycle operators must be particularly careful about driving defensively. The use of a safety helmet has been shown to significantly reduce the fatal or serious injuries sustained by motorcycle riders.

by Barbara Carraro
Publ: Traffic Safety v75 n11 p14-6, 36-8 (Nov 1975)
1975
Availability: See publication

HS-017 745

SIGNIFICANCE OF BURN TYPES, AS MEASURED BY USING THE SPARK PLUGS AS IONIZATION PROBES, WITH RESPECT TO THE HYDROCARBON EMISSION LEVELS IN S.I. [SPARK IGNITION] ENGINES

Electrical signals from cylinders of spark ignition engines, based on using spark plugs as ionization probes, are called combustion signals. These can be used to identify the three types of burns: good burns, slow burns, and misfires. A 351 cubic inch displacement (CID) production engine, modified for fast burn, and an unaltered 400 CID engine were used to analyze the contribution of each burn type to hydrocarbon (HC) emissions. The fast burn engine had a conventional chamber with 30% squish, shrouded valves, and a 10.6:1.0 compression ratio. During a typical measurement, a steady state engine operating condition was established and 500 to 1000 successive plug firings from a specific cylinder were recorded. The variation in the average statistical occurrence of various burn types during simulated decelerations indicated that the mode of combustion degradation is similar regardless of the engine used. It was found that in a continuous fashion, as deceleration became more severe or as the exhaust gas recirculation was increased, more and more spark plug initiated combustions turned into slow combustions. Slow burns were found to produce 3 to 13 times, while misfires produced 18 to 24 times the HC exhaust level of good burns.

by William G. Rado; Wayne J. Johnson
Ford Motor Co.
Rept. No. SAE-750354; 1975; 10p 1ref
Presented at the Automotive Engineering Congress and
Exposition, Detroit, Mich., 24-28 Feb 1975.
Availability: SAE

HS-017 746

OFF-STOICHIOMETRY OPERATION OF AN SI [SPARK IGNITION] ENGINE. A MODEL OF FORMATION AND CONTROL OF NITRIC OXIDE

The highest concentrations of nitric oxide (NO) appear in the exhaust of a spark ignition engine when it is operated slightly on the lean side of stoichiometry. A method of control might be to run the engine at an off-stoichiometric air/fuel ratio where the NO emission is low. Operating the engine in the fuel rich region entails high emissions of carbon monoxide (CO) and is not compatible with the idea of conserving energy. The method takes account of this super-concentration of oxygen in the flame front in order to predict NO emission levels. The model is based on a modular concept. Extrapolations of flame speeds in the engine were made beyond the measured range and were used as a module in the model. A residual mass fraction was assumed to be present at the start of the induction stroke. To test the accuracy of the model experimental work was conducted on a single cylinder four stroke, variable compression ratio, Renault spark ignition engine. A constant speed and a fixed compression ratio were maintained for the experiment. The optimum spark firing time was used. The accuracy of the NO prediction is better using this model than previous ones. The inclusion of a measured temperature might help resolve some discrepancies between the model and the actual situation. It was concluded that the effect of the partial equilibrium assumption in and near the reaction zone is to increase the NO levels in the lean mixtures range. It has little ef-

fect on rich mixtures. For the lean mixtures region the model is sensitive to changes in the main parameters in the combustion process. Formation and decomposition of NO can be adequately described by the Zeldovich mechanism provided that the correct values are assigned to the radical concentrations appearing in the kinetics process.

by G. G. Lucas; K. S. Varde
Loughborough Univ. of Tech., England
Rept. No. SAE-750352; 1975; 11p 15refs
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.
Availability: SAE

HS-017 747

POTENTIALITY OF THE MODIFICATION OF ENGINE COMBUSTION RATE FOR NOX [NITROGEN OXIDES] FORMATION CONTROL IN THE PREMIXED SI [SPARK IGNITION] ENGINE

To study the potentiality of the modification of the combustion rate for nitrogen oxide (NOx) formation control in the spark ignition (SI) engine, a mathematical model was developed. In the development of the model the following assumptions were made: the cylinder gases which had just completed combustion could be divided into a number of fractions in accordance with the weight burned; the calculations of burned gas temperature could be done disregarding mixing and heat transfer; the temperature gradient of fraction gases would be expressed as a variable based on location and time; and the six typical reactions formulas known as Zeldovich equations could be applicable to the formation of nitric oxide (NO). In order to confirm the accuracy of the predicted NO concentration results, a Datsun 4-cylinder engine was tested on an engine test bench. The NO emissions were measured using a HORIBA electrochemical luminescent analyzer. The tests were run using rich and lean mixtures and with or without exhaust gas recirculation (EGR). The results showed very good coincidence under various operating conditions. The model was then used to judge the effects of the modification of the combustion rate on NOx formation. The level of NO formation correlates with the specific fuel consumption (sfc) for the various heat release functions evaluated. The application of the EGR technique would be the most promising approach for reduction of the combustion gas temperature with minimum sfc loss as the first stage of NO emission control.

by Hiroshi Kuroda; Yasuo Nakajima; Kunihiko Sugihara;
Yasuo Takagi
Nissan Motor Co., Ltd., Japan
Rept. No. SAE-750353; 1975; 11p 15refs
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.
Availability: SAE

HS-017 748

WHAT MAKES CARS HANDLE?

The fundamentals of automobile dynamics are discussed. In any car driven by the rear wheels, there are fundamental dynamic advantages in rearward weight-bias. This is generally accomplished by placing the engine behind the driver. Quite a few front-engined cars manage to carry the greater percentage of their weight on the rear wheels. Secondary advantages of a rearward weight bias include: the engine and drive train

become a compact one-piece unit; the field of view can be improved with the bulk of the engine behind the driver; and a rear-engine chassis can be strengthened and reinforced by the transaxle structure. Road racing has led the way with innovations and development that found their way into passenger cars; a rearward weight-bias will become more common in non-racing vehicles. The subject of automobile dynamics, or handling, is directly related to the unique qualities of tires. The rearward concentration of mass is a controlling factor in cornering behavior only because of the slip angle characteristics of tires. The slip angle can be controlled through tire and vehicle design. Within certain limits oversteer can be both useful and desirable. The average driver of a passenger car will only use the advantages of rearward weight-bias when he has to operate at or near the limit of friction, such as in cases when the road is slippery from rain or snow. A rearward weight-bias tends to offset the vertical force transfer so that braking effort is more equally distributed. A consideration in suspension design is control of camber, the angle of the plane of the wheel relative to the horizontal plane of the road. There are two basic approaches to the control of roll couple distribution: spring rates in roll and relative roll center heights. Roll centers are points, determined by suspension geometry, about which the car tends to rotate when subjected to a side force. Graphs and illustrations help to explain the forces which affect handling of a car.

by Jim Hall; David E. Davis, Jr.
Publ: Vehicle Handling and Control, Rochelle Park, N.J., n.d.
p3-18
n.d.

Availability: In Vehicle Handling and Control, ADI Press, Box M, Rochelle Park, N. J. 07662 \$12.95

HS-017 749

THE EFFECT OF ENGINE DESIGN PARAMETERS ON COMBUSTION RATE IN SPARK-IGNITED ENGINES

Fast combustion rates tend to produce low nitrogen oxides (NOx) levels. An experimental program was conducted to develop quantitative data on the effect of some of the engine design features that significantly effect the combustion rate. A 1972 351C was the base engine for this study. Modifications were made in the cylinders one and eight for the installation of a pressure pick up and to achieve all combinations of the following combustion parameters at two levels: squish production open and 30% squish chamber; spark gap position, production and 0.67 in toward bore centerline; swirl, production 0 to 5000 rpm swirl; and charge velocity, production and high velocity port. A data gathering system recorded incremental cylinder pressures during the combustion cycles for calculation of results by computer. A 460 cubic inch BIP engine was used for comparison purposes. Increasing the compression ratio from 8.3 to 10.9:1 on an open chamber 351C engine did not change the time it took to burn from 10 to 90% of the charge. The ignition time delay was reduced by 22%. Each of the parameters under study separately produced burn time reductions. By including factors in combination, burn time was 58% of a production configuration burn time. The effect of each parameter was dependent on the inclusion of another factor. The single factor that resulted in the largest average reduction in burn time, independent of other factors, was spark plug gap location. The burn time of the 460 cubic inch bowl-in-piston engine was 36% of a production 351C and 62% of the fastest modified 351C chamber burn time. Decreasing burn time while

maintaining MBT spark increased hydrocarbon emissions from modified 351C chambers. Decreasing burn time with 20% EGR reduced NOx emissions from modified 351C chambers. Other results of decreasing burn time are a decreased ignition delay time and combustion cyclic variation. Included as appendices are the effects of operating conditions on combustion and a factorial analysis of results.

by J. Mayo
Ford Motor Co., Combustion Engineering Dept.
Rept. No. SAE-750355; 1975; 22p 9refs
Presented at the Automotive Engineering Congress and
Exposition, Detroit, Mich., 24-28 Feb 1975.
Availability: SAE

HS-017 750

THE BASIC NATURE OF VEHICLE UNDERSTEER- OVERSTEER

This definition of understeer-oversteer departs from convention by dealing with transient as well as steady state conditions. A vehicle has a neutral steer response if the change of the lateral force produces no change in its yaw. If the yaw velocity increases when the lateral acceleration is increased in a moving vehicle, the vehicle is said to oversteer. If the yaw velocity decreases the vehicle understeers. The understeering-oversteering properties of a vehicle vary widely with changes in operating conditions and cannot be expressed quantitatively unless these conditions are specified. Understeer and oversteer can originate from disturbance inputs and by steer inputs. Disturbance inputs are unbalanced lateral components of inertia applied to a vehicle in a cornering maneuver or in a straight ahead motion. The understeer values of various design factors were determined by the difference between the steady-state understeer rate of the near-neutral vehicle before and after the addition of this factor. The design factors under consideration are: the aligning torque, fore-and-aft weight distribution, dynamic camber, geometrical toe range, compliance toe range, and rear axle roll steer. The subjective feel of a vehicle improves as the yaw damping increases, also the steady-state understeer rate increases up to 70%. Dynamic wind stability can be measured by means of cumulative steering counters. The location of the resultant lateral tire force, with respect to gravity, is the major factor determining the amount of vehicle understeer-oversteer. The value of understeer produced by an individual design factor varies with a change of the understeer for the whole vehicle; one design factor viewed alone gives an incomplete picture. Equations that explain vehicle motion are included in the appendix. Following the paper there is a discussion of its contents by representatives from Giannini Controls Corp., Chrysler, and General Motors. The author closes the discussion with his own comments.

by Walter Bergman
Publ: Vehicle Handling and Control, Rochelle Park, N.J., n.d.
p33-68
n.d.; 8refs
Availability: In Vehicle Handling and Control, ADI Press, Box
M, Rochelle Park, N.J. 07662 \$12.95

HS-017 751

COST-BENEFIT AND COST-EFFECTIVENESS ANALYSIS IN DETERMINING PRIORITIES AMONG

MOTOR VEHICLE SAFETY STANDARDS, PROGRAMS AND PROJECTS

The methodological issues associated with cost-benefit and cost-effectiveness analyses in traffic safety have been under discussion for a number of years, but these techniques have not been implemented at Federal, state, and local levels. This situation is rapidly changing. The Congress has mandated the measurement of costs and benefits with respect to certain standards. Relevant activities are currently underway within the National Highway Traffic Safety Administration, the Federal Highway Administration, the National Cooperative Highway Research Program, certain industry groups, and among several state and local agencies. The idea is to apply these techniques to the determination of priorities among motor vehicle safety standards, programs, and projects. The development of recommended procedures will focus attention on the real issues and the unresolved relationships, and away from mainly emotionally and politically motivated issues. The procedure development can act as a unifying mechanism to the parties involved in the traffic safety issues. There seems to be considerable confusion among highway safety planners concerning the proper role of evaluation methodologies. The absolute magnitude of the benefit-cost ratio for a particular project will be influenced by whether a particular economic impact is added to the numerator as a benefit or subtracted from the denominator as a negative cost. Cost-effectiveness analysis differs mainly from cost-benefit analysis in that effectiveness measures are generally stated in other than monetary terms. Without the conversion into like terms it is less reasonable to expect a single solution to emerge. The application of these techniques in the Federal Traffic Safety Program, with special emphasis on the California experience, is reviewed.

by G. A. Fleischer; George P. Jones
University of Southern California
Publ: HS-801 745, International Congress on Automotive
Safety (4th) Proceedings, Washington, D.C., 1975, p173-92
1975; 43refs
Meeting held 14-16 Jul 1975.
Availability: In HS-801 745

HS-017 752

FRENCH AND EUROPEAN DIFFERENT METHODOLOGICAL APPROACHES TO SAFETY STANDARDS

France is cooperating with other European countries to develop a safer passenger car. The program of developing and demonstrating such a vehicle includes: quantification of the need; a determination of injury criteria, through clinical investigations; and research into alternative designs. Quantification can establish and underline the dangers at stake characterizing them by frequency of occurrence, implication risk levels, and severity. The expediency of a specific regulation can be determined by analyzing the maximum acceptable cost of the measure, the cost benefit rate or the rate of economic return, and the frequency of an accident problem. Once the best solutions to traffic safety problems have been sorted out the next step is to test them. Priority and practicability ratings were given to a number of possible changes in car design and equipment. Changes that receive the top priority rating are: the improvement of seat belts, pedestrian protection, and the ability to withstand frontal impact. The improvement of seat belts and frontal impact attenuation also have the highest practicability rating. Building pedestrian safety into cars gets a doubt-

ful practicability rating. Medium priority measures are: the ability to withstand a side impact, the improvement of brakes, tires, handling, lighting, visibility, and driver field of view. Improvement of handling is the least practical of this grouping. Lower priority needs are: rollover and rear impact attenuation, fire prevention, the release/escape of occupants, and the development of driving aids.

by M. Frybourg
Transportation Res. Inst., France
Publ: HS-801 745, International Congress on Automotive Safety (4th) Proceedings, Washington, D.C., 1975, p193-208
1975

Meeting held 14-16 Jul 1975.

Availability: In HS-801 745

HS-017 753

COMPULSORY MEASURE OF SAFETY BELT WEARING IN FRANCE

The first law in France concerning safety belts made the installation of three-point seat belts compulsory for all passenger cars sold after April 1, 1970. In July 1973, seat belt wearing became compulsory for both the driver and the front seat passenger. Before the compulsory measure, a campaign to encourage seat belt wearing was carried out but results were disappointing. A national poll undertaken in March 1973, showed that while 80% of the persons interviewed had a favorable opinion of seat belts, only about 28% of the drivers were wearing their belts. As a result of this regulation, media promotion, and educational programs, more than 80% usage was observed in 1975. Over 1,000 lives were saved in France because of this compulsory seat belt law. Such a law is an effective way of saving lives at a low cost. Compulsory retroactive installation in passenger cars came into effect on July 1, 1975. Other proposed requirements include: installation of seat belts with automatic retractors for the front seats of new cars; seat belts for the rear seats; and installation in industrial and commercial vehicles.

by C. Gerondeau
Publ: HS-801 745, International Congress on Automotive Safety (4th) Proceedings, Washington, D.C., 1975, p235-9
1975

Meeting held 14-16 Jul 1975.

Availability: In HS-801 745

HS-017 754

IS REGULATION WITHOUT RESPONSIBILITY TYRANNY?

The value of government regulations regarding automobile safety is questioned. The viewpoint that many regulations do not show significant results is taken. The National Highway Traffic Safety Administration has already issued 48 Federal motor vehicle safety standards (MVSS's), 13 regulations including labelling and reporting, and five consumer information regulations. The Federal Highway Administration promulgated 18 additional highway safety standards. Some standards have been contested in court, and parts of some standards have been determined invalid. Congress itself intervened in the case of air bags, seat belt and ignition interlocks. The death rate did go down a few percentage points because of MVSS's. Collapsible steering wheels, shatter-proof windshields, and seat belts yielded a small but significant payoff. After these changes it became harder and more expensive to make changes that

would demonstrably lessen the effect of highway accidents. The reduction of the speed limit to 55 mph did more to reduce the mortality rate than all of the MVSS's put together. A more systematic decision-making process for MVSS's and other Department of Transportation regulations, plus a program for careful, follow-up evaluation is needed. The decision making step should include an objective study of projected costs. Federal regulators and their regulations add \$130 billion a year to the cost of what people buy (\$2,000 for each American family). Government regulators are playing an ever more prominent role in American business; an evaluation system of the regulation process might help reverse this trend.

by Malcolm R. Lovell, Jr.
Rubber Mfgs. Assoc.
Publ: HS-801 745, International Congress on Automotive Safety (4th) Proceedings, Washington, D.C., 1975, p413-8
1975

Meeting held 14-16 Jul 1975.

Availability: In HS-801 745

HS-017 755

RESEARCH AND DEVELOPMENT IN FUTURE AUTOMOBILE REGULATION

The National Highway Traffic Safety Administration's research efforts are in two major directions: crash avoidance and crashworthiness. The crash avoidance research tries to reduce the frequency and severity of highway crashes by improving the dynamic performance of the driver-vehicle system. The crashworthiness research effort attempts to reduce the frequency and severity of injuries, fatalities, and economic loss resulting from accidents involving motor vehicles. There are four basic steps common to both research programs. First, the problems are defined in terms of frequency and severity. The next step is to run laboratory simulations. The third step is to design, develop, and test automotive equipment. The final stage is to interpret the outcome of the test in terms of the real world. The Research Safety Vehicle (RSV) program has begun the difficult task of relating four major societal goals: safety, environment, economy, and energy use reduction, in a single vehicle design. In place of strict standards in the areas of safety, environment, and energy usage, there has been a move to increase the manufacturers' flexibility in creating designs that do an all around job of meeting these goals. Overseas manufacturers have been very aggressive in adopting experimental safety vehicle (ESV) features in their production cars. The following manufacturers are using ESV features in their production cars: Mercedes-Benz, Volkswagen, and Volvo. Pictures of the ESVs are included. Graphs illustrate the kinds of variables that need to be considered in designing an ESV. The following RSV's are shown: an AMF design, a Ford design, a Volkswagen design, a Calspan design, and a Minicars design. The S3E concept, a program for judging how the personal automobile can best be planned to give the mobility that society demands from it and yet satisfy growing energy, environmental, and economic constraints, is discussed.

by Gene G. Mannella
National Hwy. Traffic Safety Administration
Publ: HS-801 745, International Congress on Automotive Safety (4th) Proceedings, Washington, D.C., 1975, p455-85
1975

Meeting held 14-16 Jul 1975.

Availability: In HS-801 745

HS-017 756

ACCIDENT INVESTIGATION IN THE EVALUATION OF SAFETY STANDARDS. A SURVEY OF METHODOLOGY AND APPLICABILITY

For the development of safety standards, it is necessary to conduct a careful and comprehensive analysis of the accident situation. Despite a large amount of accident data in the United States there is still no uniform, nationwide valid accident data base. Nevertheless, accident data can be prepared for complex benefit/cost analysis of safety measures in ways suitable for the evaluation of safety standards from the automotive engineer's point of view. The methods of determining the absolute nationwide numbers of injuries versus accident type, seat position, impact location, single vehicle and vehicle-to-vehicle accidents are described. Also described is the process of determining how an accident projection is carried out; how the accident data, apart from injury causation, are evaluated with a view to accident mechanics; how injuries as a function of vehicle velocity in accidents are determined; and how the effectiveness of safety measures is evaluated. The determination of safety standards on the basis of accident data is not without uncertainties. Better and more comprehensive accident data are needed. The effectiveness ratings were established under the assumption that the safety measures fulfill the following tests: frontal impact with Moveable Deformable Barrier (MDB), 4000 lbs; frontal impact with MDB, 4000 lbs (test of passenger compartment structural integrity); frontal impact with Moveable Rigid Barrier (MRB), 2000 lbs; frontal impact with fixed pole; rear impact with MDB, 4000 lbs; rollover; and a dynamic roof crush test.

by Ruediger Schmidt
Volkswagen Res. Div.

Publ: HS-801 745, International Congress on Automotive Safety (4th) Proceedings, Washington, D.C., 1975, p605-65
1975; 4refs

Availability: In HS-801 745

HS-017 757

AN ASSESSMENT OF THE RELATIONSHIP BETWEEN FRONTAL IMPACT SPEED AND FATALITIES

An assessment was made of the cumulative distributions of fatalities and injuries as a function of crash severity using in-depth Collision Performance and Injury Report (CPIR) data (for 862 fatalities of which 281 unrestrained, front-seat adults, aged 15-98 years were studied) and Texas police-reported data (for 828 Texas passenger car frontal-impact fatalities reported in 1973). It was found that: the exact forms of the cumulative distributions are dependent upon the set of data used and upon the set of analytical techniques used; fatalities are associated with other factors than speed alone; and the probability of being killed is the product of the risk of fatality for each set of crash factors times the chance that each combination of crash factors will occur. It is concluded that: vehicle safety design changes or a shift away from single-vehicle rural collisions can alter the distributions of fatalities; existing accident data are inadequate for the preparation of an accurate and representative fatality distribution by speed (or severity); and an up-to-date national sample with sufficient data for preparation of a representative cumulative fatality curve by speed (or severity) is needed.

by Joseph C. Marsh, 4th.; Barbara C. Brown
University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich. 48105
Rept. No. UM-HSRI-SA-75-8; 1975; 55p 13refs
Supported by the Motor Vehicle Manufacturers Assoc.
Availability: Corporate author

HS-017 758

MOTOR CARRIER ACCIDENT INVESTIGATION. COWBOY'S PRODUCE COMPANY, ACCIDENT--APRIL 2, 1975--TIFTON, GEORGIA

A night-time accident involving a cab-over-engine tractor trailer truck's collision with the rear of a passenger automobile is reported. The truck, travelling at 60 mph, overtook and struck a slower-moving 1961, 4-door, Chevrolet Belair station wagon on an Interstate highway (with a 55 mph speed limit) in Georgia. The fuel tank of the car ruptured, and, as the truck veered to its left and overturned on the highway median, the automobile ran off the road to the right, down an embankment, and overturned onto its roof and burned. The driver of the truck, a 38-year-old male with 15 years trucking experience, had been convicted of speeding 17 times from 1956 to 1973 and his Georgia driver's license had been suspended twice. He was injured in the crash. The 39-year-old male driver of the automobile was accompanied by eight relatives. He and six of his relatives were killed and the car was virtually destroyed. It is concluded that the probable cause of the accident was the operation of a tractor trailer truck by a fatigued truck driver dozing at the wheel. The driver was in violation of Federal regulations regarding hours of on-duty time for drivers. He was operating the truck without a proper driver's license, was using a fraudulently prepared medical certificate, and was not preparing his daily log.

Bureau of Motor Carrier Safety, Washington, D.C.

Rept. No. 75-2; 1975; 11p

Availability: Corporate author

HS-017 759

CONTROL OF LARGE COMMERCIAL VEHICLE ACCIDENTS CAUSED BY FRONT TIRE FAILURE. FINAL REPORT

An investigation of front tire failure on heavy trucks is reported. The investigation included a study of the magnitude of the front tire problem, baseline tire failure tests, and tests with devices commercially available and designed to minimize the front tire failure problem. The study of the front tire failure problem included examination of the following: general trucking industry statistics; truck accident statistics; characteristics of truck tire failure accidents; causes of front tire failure; and steering and alignment factors (flat tire on a straightaway, overrunning an obstruction, and blowout on a curve). One three-axle cab-over-engine tractor weighing over 26,000 pounds with two identical 40 foot trailers, one empty (28,380 pounds gross combination weight) and one filled (73,280 pounds gross combination weight) was used in all tests. Common test conditions were: test speed of 50 mph; left-front tire failed (solenoid triggered double-barrel shotgun attached to front axle fired slugs into tire when switch-activated by driver); tire manufacturer's recommended pressure of 90 psi; transmission in high gear with clutch engaged; truck coasting with throttle control released; brakes not applied until several seconds after deflation; and steering manually controlled by

concepts, safety roller, hydraulic devices, power-assisted steering, and cantilever tire. It was found that: the safety roller, centerpoint axle, cantilever tire, and centerline axle devices show a significant improvement over baseline conditions; power assist shows a marked reduction in required steering torque to control the vehicle; the maximum total benefit (annual accident cost) of \$28 per truck compares reasonably well with the computed annual cost per truck of the factory-installed centerline and centerpoint axles (\$37) and is not much less than the cost of the cantilever tire (\$36-\$54); and the maximum benefit to the operator would be \$12 per year per truck, less than the computed costs of any of the safety devices.

by R. L. Anderson; R. A. Nidey; G. McCormick; F. Russoniello
Ultrasystems, Inc., Dynamic Science Div., 1850 West Pinnacle Peak Rd., Phoenix, Ariz. 85027
Contract FH-11-8562
Rept. No. 2320-75-130 ; 1975 ; 257p 30refs
Rept. for Sep 1974-Aug 1975. Sponsored by the Bureau of Motor Carrier Safety.
Availability: NTIS

HS-017 760

A STUDY OF TECHNOLOGICAL IMPROVEMENTS TO OPTIMIZE TRUCK CONFIGURATIONS FOR FUEL ECONOMY. FINAL REPORT

A study of truck fuel economy is described. Truck types accounting for most of the fuel consumed were identified and modeled by computer analysis: class I (0-6,000 pounds); class II (6,001-10,000); class VI (19,501-26,000); and class VIII (33,001 and over). Baseline fuel consumption was calculated for the major truck types over specific duty cycles (long, short, local, and mixed duty cycles). Design improvements in the truck were then modeled (power plant, cooling system, power train, differential gear, tire, aerodynamic, and weight improvements), and the effect on fuel economy was estimated. Total life cycle costs for the incorporation of improvements were developed for single improvements and combinations of improvements. Results indicated that fuel economy gains of up to 40% could be made in classes I and II, 70-80% in class VI van-type, local-delivery trucks, and 15-30% in class VIII depending on the type of truck and use. These four classes account for over 85% of the fuel consumed by the entire truck fleet. It is estimated that the technological changes required to mass produce these more fuel efficient vehicles could be accomplished in the 1980's.

by Donald A. Hurter; W. David Lee
Arthur D. Little, Inc., Acorn Park, Cambridge, Mass. 02140
Contract DOT-TSC-627
Rept. No. DOT-TSC-OST-75-46 ; 1975 ; 164p 28refs
Rept. for May 1974-Jan 1975.
Availability: NTIS

HS-017 761

THE DRIVING SEAT. ITS ADAPTATION TO FUNCTIONAL AND ANTHROPOMETRIC REQUIREMENTS (LE SIEGE DU CONDUCTEUR:

FONCTIONNELLES ET ANTHROPOMETRIQUES)

The driving seat is analyzed in its relationship with the various functions to be carried out from the driving position. The driver's task is examined, the body posture best meeting the task requirements is determined, and seat characteristics giving optimum support to the driver are defined. Seat characteristics obtained in this manner include: seating height, the location and extent of the adjustment zone, the seat back inclination, the cushion inclination, and the static consistency of the cushion (pressure distribution between the sitter and the cushion and under the thighs). It is concluded that the definition of the dynamic characteristics of a seat cannot be described other than by considering the seat as an element in a more complex structure where the vehicle and human body operate as systems of suspended masses.

by R. Rebiffe
Rept. No. RAE-Lib-Trans-1841; N75-27764 ; 1975 ; 24p 7refs
Translated from the French by the Royal Aircraft Establishment, London. Originally published in the Proceedings of the Symposium on Sitting Posture, 1969.
Availability: NTIS

HS-017 762

TRANSPORTATION CONTROLS TO REDUCE AUTOMOBILE USE AND IMPROVE AIR QUALITY IN CITIES, THE NEED, THE OPTIONS, AND EFFECTS ON URBAN ACTIVITY

As part of the Energy Supply and Environmental Coordination Act of 1974, a report is presented on the necessity of parking surcharge, management of the parking supply, and preferential bus/carpool lane regulations as part of the applicable implementation plans required to achieve and maintain national primary ambient air quality standards. Included are an assessment of the impact of such regulations, consideration of alternative means of reducing total vehicle miles traveled, and an assessment of the impact of such regulations on other Federal and state programs dealing with energy or transportation. It is concluded that: a 20% reduction in automobile travel achieved by diverting commuters to transit could reduce energy consumption for urban passenger transportation by 10% or more; the diversion of travellers from cars to transit will reduce both traffic fatalities and accident costs; the use of transit and carpools can significantly reduce both traffic congestion and the need for further highway construction; reductions in automobile use (from this diversion) could reduce the total direct monetary costs of urban commuter transportation by as much as \$100 per commuter per year; improved transit service associated with transportation controls will increase the mobility of persons with no access to automobiles; and the revenues derived from parking surcharges can contribute significantly to defraying the costs of transit improvements while alleviating the effects of the underpricing of automobile travel. State-by-state status reports of transportation control plans, preambles to indirect source regulations, and a copy of the proposed Clean Air Act amendment for transportation control plans are provided.

by Joel Horowitz; Steven Kuhrzt
Environmental Protection Agency, Office of Air and Waste Management, Washington, D.C.
Rept. No. EPA-400/11-74-002 ; 1974 ; 74p 85refs
Includes reprints from the Federal Register for vol. 39, no. 38, part 3, and vol. 39, no. 132, part 2.
Availability: Corporate author

HS-017 763

ENGINE PERFORMANCE TEST OF THE 1975 CHRYSLER-NISSAN MODEL CN633 DIESEL ENGINE. INTERIM REPORT

An engine test of the Chrysler-Nissan Model CN633 diesel engine was performed to determine its steady-state fuel consumption and emissions (hydrocarbons (HC), carbon monoxide (CO), and nitrogen oxides (NOX)) maps. Total engine operating time (break-in and testing) was about 100 hours. The engine was mounted on a test stand, coupled to an eddy-current dynamometer, and operated at the following steady state modes: 1000, 1600, 2000, 2300, 2800, 3300, and 3800 rpm; 0, 5, 10, 25, 50, 75, 85, 95, and 100 percent of full load; and 0, 1, 3, 6, and 9 horsepower idle speed loads (plus load equivalent to transportation in "drive"). A total of 106 tests were run. Results are sufficient to establish the steady-state maps for fuel consumption and emissions over the engine's entire operating range.

by W. F. Marshall; K. R. Stamper
Energy Res. and Devel. Administration, Bartlesville Energy
Res. Center, P.O. Box 1398, Bartlesville, Okla. 74003
Contract RA-75-10
Rept. No. DOT-TSC-OST-75-44 ; 1975 ; 35p
Rept. for Jun 1975.
Availability: NTIS

HS-017 764

AUTOMOTIVE GLASS

An overview of the present state of the art in the automotive glass industry is presented. A brief historical discussion of the development of automotive glass is provided and glass materials (sand, soda ash, dolomite, limestone, saltcake, carbon, rouge, and cullet) are discussed. Various glassmaking processes are considered: basic glassmaking; tinting; bending the glass; windshield production; tempering; and heated backlight production. Future development possibilities are also discussed: thinner, stronger, lighter weight automotive glass; phototropic glass; and electrically heated windshields.

by Larry Givens
Publ: Automotive Engineering v83 n11 p32-9 (Nov 1975)
1975
Availability: See publication

HS-017 765

A NOTE ON SKID RESISTANCE AND THE ROAD PROFILE

Skid resistance information from many sources throughout the United States (U.S.) is summarized in an effort to determine whether surfaces with skid numbers (SN) below 35 should be used in traction grading. Some results of surveys of road surfaces (generally either portland cement concrete, bituminous surface treatment, nonbituminous surface treatment, or unsurfaced dirt) are presented. Total road and street mileages in the U.S. by surface type for the period 1900-1972 is graphed and the effects of worn tires on vehicle accidents are discussed. It appears that: about one third of U.S. road surfaces, or slightly over one-half million miles, are in the low SN range (less than 30-35); and as one improves one area of low skid number, other areas are being polished to a lower skid resistance level, and the result is an equilibrium between developing low skid

resistance areas and areas which have had their skid resistance increased. It is recommended that: a constant inventory of skid resistance be maintained to determine repair priorities and minimize accidents; and a slippery surface (20-25 SN) be included in a test procedure for tire traction/grading.

by Harry Williams
National Hwy. Traffic Safety Administration, Safety Res.
Lab., Washington, D.C. 20590
Publ: Tire Science and Technology v3 n4 p267-73 (Nov 1975)
1975 ; 22refs
Availability: See publication

HS-017 766

TIRE TREAD PATTERN SOUND GENERATION

An assessment of a mathematical method of synthesizing tire sound spectra is presented. The method is based on the summation of phasors and the calculated spectra are generated as computer printout in the form of bar graphs. The technique, its usefulness, its limitations, and the implications of using such a model are discussed. Four tubeless bias ply passenger tires were molded, three of them were transverse grooved to form block patterns of varying pitch and element sequence, and all of them were run on an indoor test machine to carry out a frequency analysis (using a frequency meter with a photoelectric pickup head). It was found that the plain rib pattern (not transverse grooved) best approximates the most desirable sound spectrum. However, such tread patterns are impracticable with respect to other tire operating requirements, particularly wet road holding. It is concluded that tread patterns should be oriented in the circumferential direction as much as possible, but tread patterns with the necessary transverse grooves, or block patterns, can still be optimized with regard to sound generation.

by P. R. Willett
Publ: Tire Science and Technology v3 n4 p252-66 (Nov 1975)
1975 ; 30refs
Availability: See publication

HS-017 767

EFFECT OF TIRE WEAR ON WEAR RATE

Experiments on tires were made in attempt to answer three questions: is the wear rate of tires constant under constant conditions, are commercial tires uniform enough to serve as monitors of environmental change, and how can the wear rate be estimated? The tires used for all of the experiments were given a 800-mile break-in and were rotated every 800 miles. For the 27 tires tested, the regression of the average groove depth against mileage gave a straight line which accounted for over 99% of the variability with a standard deviation of about 2 mils. The tread life projected from a 6,400-mile test gave on the average the same tread life as projected from higher mileages. A bias tire built under stringent quality control specifications and the radial tire selected for monitoring environmental effects were very homogeneous. The bias and belted course-monitoring tires were more variable. The intrinsic wear rate of tires was constant. Accurate tread life projections could be made from short mileage tests. The wear rate estimated from the slope of the regression line of average groove depth against mileage is preferred; this method avoids problems arising from the use of the arithmetic or geometric mean. The multiplicative model is preferred over the arithmetic model for

analysis to determine the effects of factor effects (such as wheel position and test positions) on the wear rate.

by F. C. Brenner; S. R. Scheiner; Akira Kondo
 Publ: Tire Science and Technology v3 n4 p235-51 (Nov 1975)
 1975 ; 7refs
 Availability: See publication

HS-017 768

THE SIGNIFICANCE OF TREAD ELEMENT FLEXIBILITY TO THIN FILM WET TRACTION

Tire carcass flexibility affects thick film, wet traction performance. If the tread pattern becomes flooded, the inertial force of the water will cause the tire as a whole to flex inward, creating a thick film pocket of fluid in the lead and central portions of the footprint. An analysis has been made of the action of individual tire tread elements on polished sections of pavement that are covered by thin fluid films. Tread element flexibility, wheel slip, and time dependent loading conditions are incorporated in this analysis. Tread element flexibility is found to have a great effect on the nature of the squeeze film event. Viscous hydroplaning is dependent on whether or not there is sufficient microtexture to allow the pocket of fluid trapped between the surface of the flexible tread element and the pavement to escape. Classical rigid plate, squeeze film analysis was shown to be inadequate for designing tread elements that have good traction on wet pavements. The lateral expansion of the tread elements preceding contact was found to be quite small, it, therefore, can have little effect on sipe and groove closure. The magnitude of the applied load and the elastic modulus of the tread element had significant effects on the squeezing action of the tread elements. Slip velocities less than 4.5 meters per second had little effect.

by A. L. Browne; D. Whicker; S. M. Rohde
 Publ: Tire Science and Technology v3 n4 p215-34 (Nov 1975)
 1975 ; 26refs
 Availability: See publication

HS-017 769

CUMULATIVE FATIGUE DAMAGE ANALYSIS OF A LIGHT TRUCK FRAME

The objective of this fatigue damage analysis of a light truck frame was to determine whether an existing frame design can safely accept a 10% increase in load. To investigate the adequacy of the frame, it was necessary to identify the highly strained, critical areas. A brittle lacquer coating was applied to the frame. After the lacquer had dried, the vehicle was driven over a proving ground route. Cracks formed in the brittle lacquer coating around the more highly strained areas. Resistance strain gauges were mounted at the maximum strain locations. All magnetic tapes of the strain-time recordings were examined using a computer technique, and the maximum peak dynamic strains were determined. Monotonic tension tests were performed on specimens removed from the light truck frame perpendicular and parallel to the rolling direction of the frame siderail. The results indicated that stress-base cumulative damage procedures may be inaccurate because they do not account for non-linearity of stress and strain, cyclic hardening or softening, or cyclic creep and relaxation. Strain-based cumulative damage procedures are more accurate because they circumvent some of the limitation, particularly

involving elastic assumptions, of the stress-based approach. The computer approach that employs a cyclic stress-strain relationship, a more complete representation of a fatigue response of the metal, and direct strain-time histories at critical locations, best predicts the experimental results. It was determined that the original design of the truck frame will perform adequately with the increased load. This was verified by three years of successful service. Appendices describe the construction at a predicted stress-life diagram and of a predicted strain-life diagram.

by M. R. Mitchell; R. M. Wetzel
 Publ: Journal of Testing and Evaluation v3 n6 p427-34 (Nov 1975)
 1975 ; 33refs
 Availability: See publication

HS-017 770

CHARACTERIZATION OF GALVANIZED SHEET STEEL FOR AUTOMOTIVE VEHICLE BODIES

Commercially available galvanized steel sheet materials, obtained from several sources and representing zinc coatings of conventional spangles (zinc crystal faces), minimized spangles, and diffusion alloy (galvanneal), are characterized for quality and performance. Thicknesses of the galvanized coatings were determined by chemical stripping, microscopic examination of a cross-sectioned specimen, and magnetic and eddy-current measuring devices. These methods were compared for the reproducibility and suitability for general use. Corrosion resistances of the galvanized steels were determined following specific periods of exposure of specimens in a 5% salt-fog environment. Bare galvanized steel sheets having a minimum coating thickness of 14 micrometers and averaging about 22 micrometers completely resisted rusting for 72 hours in salt fog. The adhesive and protective value of a conventional paint system applied to the galvanized materials are discussed. Welding procedures (bead and spot welding) are described. The amenability of the various galvanized materials to forming or shaping without flaking of or damage to the coatings was demonstrated. It is concluded that: in salt fog, the corrosion resistances of 1.25 commercial galvanized (G 90) steels from different sources essentially are equivalent and independent of spangle size or surface smoothness; a galvanneal coating offers less protection than the usual galvanized coating; severe bending of the various galvanized steels is not damaging to the metallic coatings; and test conditions and performance characteristics of G90 steel from different sources have been defined adequately for specification preparation purposes.

by F. Pearlstein; A. Gallaccio
 Publ: Journal of Testing and Evaluation v3 n6 p414-22 (Nov 1975)
 1975 ; 2refs
 Availability: See publication

HS-017 771

[NEW YORK STATE DEPARTMENT OF MOTOR VEHICLES] 1974 ANNUAL REPORT

The activities of the New York State Department of Motor Vehicles for 1974 are reported. Significant events in motor vehicle regulation are briefly discussed from the first New York motor vehicle legislation in 1901, to the creation of the New York Bureau of Motor Vehicles in 1924, to 1974. Active

ties of 1974 are discussed in the following sequence: organization and administration; the Counsel's office; field investigation and audit; public information; data processing; operations; program development; traffic records project; employee relations, personnel, training; safety program coordination; the Interdepartmental Traffic Safety Committee; and the Administrative Appeals Board. The following statistics are appended: motor vehicle registrations, licenses, fees collected, deductions, monies available for distribution by county for 1974; statewide total motor vehicle accidents by environmental, victim, road, time, mileage, and general situational characteristics; accidents by geographical location (vehicle and pedestrian); and county population, accident, and injury data. Also included is a summary of 1974 New York motor vehicle legislation.

New York State Dept. of Motor Vehicles

Rept. No. AR-1974 : 1975 : 32p

Availability: Office of Public Information, New York State Dept. of Motor Vehicles, Empire State Plaza, Albany, N.Y. 12228

HS-017 772

RESPONSE SPEED AS A FUNCTION OF SENSORY PATTERN AND ALCOHOL IN A VELOCITY JUDGEMENT TASK

The accuracy and rapidity of vehicle speed judgment formulation by the vehicle occupants is studied. The experiment had five fixed factors with different levels: velocity (0, 32, 64, 97, and 129 kilometers per hour); sensory modality (visual, auditory, and visual and auditory); field of view (frontal, peripheral, and both); observation time (1, 0.5, and 0.25 second); and alcohol (two normals, and 0.05, 0.075, and 0.03 grams of alcohol per 100 milliliters of blood). Three groups of five subjects each were randomly assigned to each level of the sensory modality factor. Within each level of sensory modality experimental conditions were randomly presented across velocity, observation time, field of view, and alcohol. The experiment consisted of 3,375 observations of vehicle velocity. It was found that: the acquisition of velocity information is most rapid with visual information; within the visual modality peripheral stimulation requires more processing time than frontal information; for all modalities studied reaction time increases as observation time increases from 0.5 to 1 second; interactive effects across subjects mask the effects of moderate blood alcohol levels on response speed; and interpretation is modified by field conditions and driving skill.

by Santo Salvatore

Publ: Ergonomics v18 n5 p491-502 (Sep 1975)

1975 : 17refs

Availability: See publication

HS-017 773

AN ANTHROPOMETRIC SURVEY OF 2000 ROYAL AIR FORCE AIRCREW, 1970/71

A survey, undertaken to provide up-to-date information on the body measurements of Royal Air Force (RAF) aircrewmembers for cockpit workspace and functional clothing sizing studies, is described. A team of two trained measurers, using a specially designed anthropometric rig, took 63 body measurements of each of 2000 RAF aircrewmembers between the ages of 18 and 45 at RAF stations in England. These measurements, recorded

during an 18 month period starting in January 1970, are summarized in the form of a percentile table, mean, standard deviation, range and coefficient of variation for each measurement. The statistical summary for each measurement is accompanied by a photograph illustrating the technique of measurement together with a written description of the measuring procedure. The apparatus used is fully described and the organization of the survey is briefly discussed. There are significant body measurement differences between present RAF aircrewmembers and a sample of 500 RAF aircrewmembers whose measurements were taken in 1944.

by C. B. Bolton; M. Kenward; R. E. Simpson; G. M. Turner
Royal Aircraft Establishment, England; Royal Air Force,
England; Loughborough Univ., England

Rept. No. AD-A007 948; AGARD-AG-181; RAF-IAM-R-531;

RAE-TR-73083 : 1974 : 89p 5refs

Sponsored by the Aerospace Medical Panel of the NATO
Advisory Group for Aerospace Res. and Devel.

Availability: NTIS

HS-017 774

AN ENGINE OIL FORMULATED FOR OPTIMIZED ENGINE PERFORMANCE

The development of a light viscosity engine oil formulation (XRN 1669) based on an extension of the synthesized hydrocarbon fluid lubricant technology is described. This formulation provides a significant improvement in both fuel economy and oil consumption control. The following areas of XRN 1669 in-engine performance are investigated: engine cleanliness; fuel economy (over a 13,000-mile test period); oil economy (over the same 13,000 miles); wear protection (13,000-mile test, laboratory engine tests using a four cylinder 2,000 cubic centimeter engine, 12,000 miles in a police car, and a 10,000 mile high-speed chassis dynamometer test); cold starting capability (all-weather, indoor chassis dynamometer testings); intake system cleanliness (in a 200 hour cyclic test procedure); exhaust emission level effects (over the 13,000 field test); and octane number requirement increase effects (over the same 13,000 miles). It was found that: XRN 1669 provides performance superior to premium quality, cold starting capability, intake system cleanliness, shear stability, and thermal/oxidative stability; and XRN 1669 provided wear protection at least equivalent to that of premium quality SAE 10W-40 mineral oils.

by W. H. Richman; J. A. Keller

Mobile Res. and Devel. Corp.

Rept. No. SAE-750376 : 1975 : 18p 18refs

Presented at the Automotive Engineering Congress and
Exposition, Detroit, Mich., 24-28 Feb 1975.

Availability: SAE

HS-801 505

TRI-LEVEL ACCIDENT INVESTIGATION SUMMARIES. LEVEL 3-A: INJURY CAUSATION. VOL. 4, NO. 1

The tri-level accident investigation concept is explained with emphasis on multidisciplinary in-depth information collected on a small sample of accidents by a team of professionals. The investigations were conducted to determine the specific injuries incurred and identify the specific interior components which caused them. Summaries of 54 injury producing accidents are presented. Each summary consists of six parts:

identification (date, time, and type) of the accident; a brief description of the environmental surroundings; details of damage to the involved vehicles; details of injuries, their severity and causes for each occupant of the case vehicle; a description of the precrash, crash, and postcrash phases of the collision; and a diagram of the collision sequence.

Calspan Corp., P.O. Box 235, Buffalo, N.Y. 14221
Contract DOT-HS-053-2-277
1975 ; 413p
Availability: NTIS

HS-801 506

TRI-LEVEL ACCIDENT INVESTIGATION SUMMARIES. LEVEL 3-A: INJURY CAUSATION. VOL. 4, NO. 2

The tri-level accident investigation concept is explained with emphasis on multidisciplinary in-depth information collected on a small sample of accidents by a team of professionals. The investigations were conducted to determine the specific injuries incurred and identify the specific interior components which caused them. Summaries of 54 injury producing accidents are presented. Each summary consists of six parts: identification (date, time, and type) of the accident; a brief description of the environmental surroundings; details of damage to the involved vehicles; details of injuries, their severity and causes for each occupant of the case vehicle; a description of the precrash, crash, and postcrash phases of the collision; and a diagram of the collision sequence.

Calspan Corp., P. O. Box 235, Buffalo, N.Y. 14221
Contract DOT-HS-053-2-277
1975 ; 434p
Availability: NTIS

HS-801 628

MULTIDISCIPLINARY ACCIDENT INVESTIGATION SUMMARIES. VOL. 6, NO. 10

Case reports of in-depth accident investigations are summarized. These investigations are being conducted to identify contributing factors and injury causation, to evaluate the effectiveness of countermeasures, and to detect design and functional problems of the vehicle and highway. The reports are individual, clinical studies of accidents, generally involving vehicles in the last three model years, of fatal, injury producing, or property damage severity. Each summary consists of identification information including time, date, and location of the accident, a description of the highway, vehicles, drivers, and occupants involved, a narrative of the sequence of events of the collision including details of the precrash, crash, and postcrash phases, an assessment of injuries and damage, and a list of applicable standards, causal factors, conclusions, and recommendations. A diagram of each collision is included. Summaries of 50 case reports are given.

National Hwy. Traffic Safety Administration, Office of Accident Investigation and Data Analysis Res. Inst., Washington, D.C. 20590
1975 ; 375p
Availability: NTIS

HS-801 639

PROJECT LATEDAY: THE LEVEL OF ACCIDENTS UNDER THE EFFECT OF DAYLIGHT SAVING ALL YEAR. FINAL REPORT

Estimates of the level of motor vehicle accidents under the effect of year-round daylight saving time (YRDST) and year-round double daylight saving time (DDST) are determined. An experiment was designed to employ computer analysis of available motor vehicle accident data to model the accident situation in the United States under YRDST and DDST. The Daylight Savings Equivalent Day (EQDAY) was developed to allow the available data, from non-YRDST and non-DDST years, to be used to find an estimate of the effect of YRDST and DDST. It is shown that under YRDST there would be an increase in morning accidents and a somewhat smaller increase in evening accidents, as compared to a six-month DST/six-month standard time system. An increase in yearly motor vehicle accidents of the order of one-half to one percent is estimated if YRDST is introduced. Under DDST, a large increase is shown in morning accidents and, in evening accidents, a moderate increase, compared to the six month-six month system. An increase in yearly motor vehicle accidents of the order of 4% is estimated if DDST is introduced. Injury and fatality rates for various times of day under the subject time systems are tabulated.

by David S. Prerau
Transportation Systems Center, Kendall Square, Cambridge, Mass. 02142
Rept. No. DOT-TSC-NHTSA-75-3 ; 1975 ; 133p
Rept. for Oct 1973-Apr 1975.
Availability: NTIS

HS-801 737

INVESTIGATION OF ELECTROMAGNETIC INTERFERENCE EFFECTS ON MOTOR VEHICLE ELECTRONIC CONTROL AND SAFETY DEVICES. FINAL REPORT

Results are described of a study to investigate, identify, and analyze the potential problems of electromagnetic interference from all sources (internal and external to the vehicle) that may cause malfunction of motor vehicle electronic control and electronically actuated safety devices. An analysis of inter- and intra-vehicle energy transfer and coupling is accomplished by computer simulation, utilizing modeling techniques employed for a wide range of electromagnetic design and evaluation support problems (for aircraft, spacecraft, and advanced surface ships). A technical discussion of coupling models and of receptor analysis models is provided. A computerized circuit analysis model adapted from the IBM Electronic Circuit Analysis Program is used to assess the susceptibility of representative types of electronic components and subsystems typically used in automotive electronic applications. A preliminary electromagnetic environmental source file is provided based on a literature search of vehicular internal noise sources and worst case external electromagnetic field descriptions. Validation test plans and preliminary electromagnetic compatibility guidelines for automotive electronics are summarized.

by R. H. Espeland; L. R. Teters; L. A. Jacobsen; E. L. Morrison, Jr.
Department of Commerce, Inst. for Telecommunication
Sciences, Boulder, Colo. 80302
Contract DOT-HS-4-00918
1975 : 22p 72refs
Rept. for 10 Jun 1974-1 Jun 1975.
Availability: NTIS

HS-801 747

MULTIDISCIPLINARY ACCIDENT INVESTIGATION. SPECIAL REPORT NO. 3. SCHOOL BUS FATALITY NEAR MEMPHIS, TENNESSEE

An accident involving a 1971 General Motors mini-bus with 44 occupants, including 42 children (participating in the Head Start Program), is described. The vehicle was travelling on a rural two-lane roadway at about 30-35 mph when four children fell from the vehicle at the right side sliding door, which had opened unexpectedly. One of the four children (a four-year-old female) was fatally injured and the other three sustained minor injuries. Seat belts were provided for the vehicle occupancy limit of 12 adults (equivalent to 15 children). The vehicle had many defects including evidence of pre- and post-accident side door repairs and was under no routine maintenance plan. Apparently the accident was caused by a right side door hinge failure. The driver was a 63-year-old male, a former truck driver, with no driver education experience. It is concluded that: the blame for the accident rests with the Department of Health, Education and Welfare in its failure to establish and enforce adequate guidelines to insure protection of its program's participants; and the private transportation system involved, through very bad vehicle maintenance and severe occupant overcrowding, created the setting for the death of the child. Statements of the driver, the adult occupant, and an independent witness are provided. The police accident report, medical reports, map location and on-scene photos, and letters of complaint from citizens are also included.

University of Miami, Multidisciplinary Accident Analysis
Team, Coral Gables, Fla.
Contract DOT-HS-060-3-671
Rept. No. SR-3 : 1975 : 68p 3refs
Rept. for Jun 1974-Feb 1976.
Availability: NTIS

HS-801 762

NATIONAL HIGHWAY SAFETY ADVISORY COMMITTEE. 1974 ANNUAL REPORT

The 1974 activities of the National Highway Safety Advisory Committee in advising the Secretary of Transportation on highway safety programs carried out by the Department of Transportation (DOT) are described. During 1974 the full committee (35 members) met twice to hear subcommittee reports, and formulate many important positions and recommendations for consideration by the Secretary. Recommendations or resolutions made by the Committee are given along with the replies received from DOT. Major recommendations and posi-

tions in 1974 concerned: bicyclist safety; ranking of state implementation of highway safety program standards; computer traffic records systems; improved driver-education programs; legislation permitting heavier trucks on the interstate system; the national 55 mph speed limit; use of Highway Trust Fund monies; accelerated road and safety improvement programs to provide jobs; and the standard for highway design, construction, and maintenance.

National Hwy. Safety Advisory Com., Washington, D. C.
20590
Rept. No. AR-1974 : 1975 : 54p
Availability: NHTSA

HS-801 763

NATIONAL MOTOR VEHICLE SAFETY ADVISORY COUNCIL. 1974 ANNUAL REPORT

The official activities of the National Motor Vehicle Safety Advisory Council in 1974 in advising the Secretary of Transportation on motor vehicle safety standards are outlined. The Council acts as a public voice between industry and government. During 1974 the Council met in full session 7 times and its standing and ad hoc committees met 21 times. Resolutions or recommendations made by the Council and the Secretary's or the Department of Transportation's replies are provided. Some of the important recommendations adopted by the Council in 1974 concerned: vehicle aggressivity; pedestrian protection; cost/benefit; injury tolerance, motorcycle safety; recreational vehicles; hot line, safety defects; and passive restraints.

National Motor Vehicle Safety Advisory Council, Washington,
D.C. 20590
Rept. No. AR-1974 : 1975 : 46p
Availability: NHTSA

HS-801 764

ADMINISTRATIVE ADJUDICATION OF TRAFFIC INFRACTIONS [FIRST ANNUAL] REPORT [VO.1]

An introduction to and background information on the development of administrative adjudication of traffic infractions, and an overview of the status of traffic adjudication in the various states are provided. Federal research and demonstration projects and their results are described. An independent survey conducted under contract with the American Bar Association, an executive summary, and recommendations are also included. Detailed information is provided on: a comparison of fairness, efficiency, and effectiveness; a review and collation of traffic case disposition approaches; an analysis of federally funded demonstration projects; and an assessment of the feasibility of the implementation of administrative adjudication or noncriminal traffic infraction adjudication by state and local governments.

National Hwy. Traffic Safety Administration,
Washington, D.C. 20590
Rept. No. AR-1 : 1975 : 90p
Prepared in compliance with Sec. 222 of the Hwy. Safety Act of 1973.
Availability: Corporate author

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